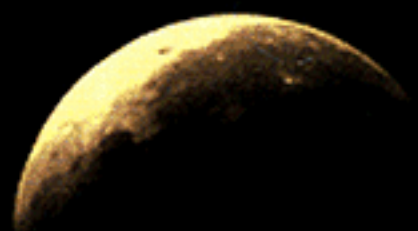


2001
A SPACE ODYSSEY



ARTHUR C. CLARKE

With a Special Introduction by the Author

2001:

A Space Odyssey

Arthur C. Clarke

Title: 2001: A space odyssey
Author: Arthur C. Clarke
Original copyright year: 1968
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Foreword

Behind every man now alive stand thirty ghosts, for that is the ratio by which the dead outnumber the living. Since the dawn of time, roughly a hundred billion human beings have walked the planet Earth.

Now this is an interesting number, for by a curious coincidence there are approximately a hundred billion stars in our local universe, the Milky Way. So for every man who has ever lived, in this Universe there shines a star.

But every one of those stars is a sun, often far more brilliant and glorious than the small, nearby star we call the Sun. And many - perhaps most - of those alien suns have planets circling them. So almost certainly there is enough land in the sky to give every member of the human species, back to the first ape-man, his own private, world-sized heaven - or hell.

How many of those potential heavens and hells are now inhabited, and by what manner of creatures, we have no way of guessing; the very nearest is a million times farther away than Mars or Venus, those still remote goals of the next generation. But the barriers of distance are crumbling; one day we shall meet our equals, or our masters, among the stars.

Men have been slow to face this prospect; some still hope that it may never become reality. Increasing numbers, however, are asking: "Why have such meetings not occurred already, since we ourselves are about to venture into space?"

Why not, indeed? Here is one possible answer to that very reasonable question. But please remember this is only a work of fiction.

The truth, as always, will be far stranger.

To Stanley



**PRIMEVAL
NIGHT**

1 - The Road to Extinction

The drought had lasted now for ten million years, and the reign of the terrible lizards had long since ended. Here on the Equator, in the continent which would one day be known as Africa, the battle for existence had reached a new climax of ferocity, and the victor was not yet in sight. In this barren and desiccated land, only the small or the swift or the fierce could flourish, or even hope to survive.

The man-apes of the veldt were none of these things, and they were not flourishing. Indeed, they were already far down the road to racial extinction. About fifty of them occupied a group of caves overlooking a small, parched valley, which was divided by a sluggish stream fed from snows in the mountains two hundred miles to the north. In bad times the stream vanished completely, and the tribe lived in the shadow of thirst.

It was always hungry, and now it was starving. When the first faint glow of dawn crept into the cave, Moon-Watcher saw that his father had died in the night. He did not know that the Old One was his father, for such a relationship was utterly beyond his understanding, but as he looked at the emaciated body he felt dim disquiet that was the ancestor of sadness.

The two babies were already whimpering for food, but became silent when Moon-Watcher snarled at them. One of the mothers, defending the infant she could not properly feed, gave him an angry growl in return; he lacked the energy even to cuff her for her presumption.

Now it was light enough to leave. Moon-Watcher picked up the shriveled corpse and dragged it after him as he bent under the low

overhang of the cave. Once outside, he threw the body over his shoulder and stood upright - the only animal in all this world able to do so.

Among his kind, Moon-Watcher was almost a giant. He was nearly five feet high, and though badly undernourished weighed over a hundred pounds. His hairy, muscular body was halfway between ape and man, but his head was already much nearer to man than ape. The forehead was low, and there were ridges over the eye sockets, yet he unmistakably held in his genes the promise of humanity. As he looked out upon the hostile world of the Pleistocene, there was already something in his gaze beyond the capacity of any ape. In those dark, deep-set eyes was a dawning awareness - the first intimations of an intelligence that could not possibly fulfill itself for ages yet, and might soon be extinguished forever.

There was no sign of danger, so Moon-Watcher began to scramble down the almost vertical slope outside the cave, only slightly hindered by his burden. As if they had been waiting for his signal, the rest of the tribe emerged from their own homes farther down the rock face, and began to hasten toward the muddy waters of the stream for their morning drink.

Moon-Watcher looked across the valley to see if the Others were in sight, but there was no trace of them. Perhaps they had not yet left their caves, or were already foraging farther along the hillside. Since they were nowhere to be seen, Moon-Watcher forgot them; he was incapable of worrying about more than one thing at a time.

First he must get rid of the Old One, but this was a problem that demanded little thought. There had been many deaths this season, one of them in his own cave; he had only to put the corpse where he had left the new baby at the last quarter of the moon, and the hyenas would do the rest.

They were already waiting, where the little valley fanned out into the savanna, almost as if they had known that he was coming. Moon-Watcher left the body under a small bush - all the earlier bones were already gone - and hurried back to rejoin the tribe. He never thought of his father again.

His two mates, the adults from the other caves, and most of the youngsters were foraging among the drought-stunted trees farther up the valley, looking for berries, succulent roots and leaves, and occasional windfalls like small lizards or rodents. Only the babies and the feeblest of the old folk were left in the caves; if there was any surplus food at the end of the day's searching, they might be fed. If not, the hyenas would soon be in luck once more.

But this day was a good one - though as Moon-Watcher had no real remembrance of the past, he could not compare one time with another. He had found a hive of bees in the stump of a dead tree, and so had enjoyed the finest delicacy that his people could ever know; he still licked his fingers from time to time as he led the group homeward in the late afternoon. Of course, he had also collected a fair number of stings, but he had scarcely noticed them. He was now as near to contentment as he was ever likely to be; for though he was still hungry, he was not actually weak with hunger. That was the most to which any man-ape could ever aspire.

His contentment vanished when he reached the stream. The Others were there. They were there every day, but that did not make it any the less annoying.

There were about thirty of them, and they could not have been distinguished from the members of Moon-Watcher's own tribe. As they saw him coming they began to dance, shake their arms, and shriek on their side of the stream, and his own people replied in kind.

And that was all that happened. Though the man-apes often fought and wrestled one another, their disputes very seldom resulted in serious injuries. Having no claws or fighting canine teeth, and being well protected by hair, they could not inflict much harm on one another. In any event, they had little surplus energy for such unproductive behavior; snarling and threatening was a much more efficient way of asserting their points of view.

The confrontation lasted about five minutes; then the display died out as quickly as it had begun, and everyone drank his fill of the muddy water. Honor had been satisfied; each group had staked its claim to its own territory. This important business having been settled, the tribe moved off along its side of the river. The nearest worthwhile grazing was now more than a mile from the caves, and they had to share it with a herd of large, antelope-like beasts who barely tolerated their presence. They could not be driven away, for they were armed with ferocious daggers on their foreheads - the natural weapons which the man-apes did not possess.

So Moon-Watcher and his companions chewed berries and fruit and leaves and fought off the pangs of hunger - while all around them, competing for the same fodder, was a potential source of more food than they could ever hope to eat. Yet the thousands of tons of succulent meat roaming over the savanna and through the bush was not only beyond their reach; it was beyond their imagination. In the midst of plenty, they were slowly starving to death.

The tribe returned to its cave without incident, in the last light of the day. The injured female who had remained behind cooed with pleasure as Moon-Watcher gave her the berry-covered branch he had brought back, and began to attack it ravenously. There was little enough nourishment here, but it would help her to survive until the wound the leopard had given her had healed, and she could forage for herself again.

Over the valley, a full moon was rising, and a chill wind was blowing down from the distant mountains. It would be very cold tonight - but cold, like hunger, was not a matter for any real concern; it was merely part of the background of life.

Moon-Watcher barely stirred when the shrieks and screams echoed up the slope from one of the lower caves, and he did not need to hear the occasional growl of the leopard to know exactly what was happening.

Down there in the darkness old White Hair and his family were fighting and dying, and the thought that he might help in some way never crossed Moon-Watcher's mind. The harsh logic of survival ruled out such fancies, and not a voice was raised in protest from the listening hillside. Every cave was silent, lest it also attract disaster.

The tumult died away, and presently Moon-Watcher could hear the sound of a body being dragged over rocks. That lasted only a few seconds; then the leopard got a good hold on its kill. It made no further noise as it padded silently away, carrying its victim effortlessly in its jaws.

For a day or two, there would be no further danger here, but there might be other enemies abroad, taking advantage of this cold Little Sun that shone only by night. If there was sufficient warning, the smaller predators could sometimes be scared away by shouts and screams. Moon-Watcher crawled out of the cave, clambered onto a large boulder beside the entrance, and squatted there to survey the valley.

Of all the creatures who had yet walked on Earth, the man-apes were the first to look steadfastly at the Moon. And though he could not remember it, when he was very young Moon-Watcher would sometimes reach out and try to touch that ghostly face rising above the hills.

He had never succeeded, and now he was old enough to understand why. For first, of course, he must find a high enough tree to climb.

Sometimes he watched the valley, and sometimes he watched the Moon, but always he listened. Once or twice he dozed off, but he slept with a hair-trigger alertness, and the slightest sound would have disturbed him. At the great age of twenty-five, he was still in full possession of all his faculties; if his luck continued, and he avoided accidents, disease, predators, and starvation, he might survive for as much as another ten years.

The night wore on, cold and clear, without further alarms, and the Moon rose slowly amid equatorial constellations that no human eye would ever see. In the caves, between spells of fitful dozing and fearful waiting, were being born the nightmares of generations yet to be.

And twice there passed slowly across the sky, rising up to the zenith and descending into the east, a dazzling point of light more brilliant than any star.

2 - The New Rock

Late that night, Moon-Watcher suddenly awoke. Tired out by the day's exertions and disasters, he had been sleeping more soundly than usual, yet he was instantly alert at the first faint scrabbling down in the valley.

He sat up in the fetid darkness of the cave, straining his senses out into the night, and fear crept slowly into his soul. Never in his life - already twice as long as most members of his species could expect - had he heard a sound like this. The great cats approached in silence, and the only thing that betrayed them was a rare slide of earth, or the occasional cracking of a twig. Yet this was a continuous crunching noise, that grew steadily louder. It seemed that some enormous beast was moving through the night, making no attempt at concealment, and ignoring all obstacles. Once Moon-Watcher heard the unmistakable sound of a bush, being uprooted; the elephants and dinotheria did this often enough, but otherwise they moved as silently as the cats.

And then there came a sound which Moon-Watcher could not possibly have identified, for it had never been heard before in the history of the world. It was the clank of metal upon stone.

Moon-Watcher came face to face with the New Rock when he led the tribe down to the river in the first light of morning. He had almost forgotten the terrors of the night, because nothing had happened after that initial noise, so he did not even associate this strange thing with danger or with fear. There was, after all, nothing in the least alarming about it.

It was a rectangular slab, three times his height but narrow enough to span with his arms, and it was made of some completely transparent material; indeed, it was not easy to see except when the rising sun glinted on its edges. As Moon-Watcher had never encountered ice, or even crystal-clear water, there were no natural objects to which he could compare this apparition. It was certainly rather attractive, and though he was wisely cautious of most new things, he did not hesitate for long before sidling up to it. As nothing happened, he put out his hand, and felt a cold, hard surface.

After several minutes of intense thought, he arrived at a brilliant explanation. It was a rock, of course, and it must have grown during the night. There were many plants that did this - white, pulpy things shaped like pebbles, that seemed to shoot up during the hours of darkness. It was true that they were small and round, whereas this was large and sharp-edged; but greater and later philosophers than Moon-Watcher would be prepared to overlook equally striking exceptions to their theories.

This really superb piece of abstract thinking led Moon-Watcher, after only three or four minutes, to a deduction which he immediately put to the test. The white round pebble-plants were very tasty (though there were a few that produced violent illness); perhaps this tall one...?

A few licks and attempted nibbles quickly disillusioned him. There was no nourishment here; so like a sensible man-ape, he continued on his way to the river and forgot all about the crystalline monolith, during the daily routine of shrieking at the Others.

The foraging today was very bad, and the tribe had to travel several miles from the caves to find any food at all. During the merciless heat of noon one of the frailer females collapsed, far from any possible shelter. Her companions gathered round her, twittering and meeping sympathetically, but there was nothing that anyone could do. If they had been less exhausted they might have carried her with them, but there was no surplus energy for such acts of kindness. She had to be left behind, to recover or not with her own resources. They passed the spot on the homeward trek that evening; there was not a bone to be seen.

In the last light of day, looking round anxiously for early hunters, they drank hastily at the stream and started the climb up to their caves. They were still a hundred yards from the New Rock when the sound began.

It was barely audible, yet it stopped them dead, so that they stood paralyzed on the trail with their jaws hanging slackly. A simple, maddeningly repetitious vibration, it pulsed out from the crystal; and hypnotized all who came within its spell. For the first time - and the last, for three million years - the sound of drumming was heard in Africa.

The throbbing grew louder, more insistent. Presently the man-apes began to move forward, like sleepwalkers, toward the source of that compulsive sound. Sometimes they took little dancing steps, as their blood responded to rhythms that their descendants would not create for ages yet. Totally entranced, they gathered round the monolith, forgetting the hardships of the day, the perils of the approaching dusk, and the hunger in their bellies.

The drumming became louder, the night darker. And as the shadows lengthened and the light drained from the sky, the crystal began to glow.

First it lost its transparency, and became suffused with a pale, milky luminescence, tantalizing, ill-defined phantoms moved across its surface and in its depths. They coalesced into bars of light and shadow, then formed intermeshing, spoked patterns that began slowly to rotate.

Faster and faster spun the wheels of light, and the throbbing of the drums accelerated with them. Now utterly hypnotized, the man-apes could only stare slack-jawed into this astonishing display of pyrotechnics. They had already forgotten the instincts of their forefathers and the lessons of a lifetime; not one of them, ordinarily, would have been so far from his cave, so late in the evening. For the surrounding brush was full of frozen shapes and staring eyes, as the creatures of the night suspended their business to see what would happen next.

Now the spinning wheels of light began to merge, and the spokes fused into luminous bars that slowly receded into the distance, rotating on their axes as they did so. They split into pairs and the resulting sets of lines started to oscillate across one another, slowly changing their angles of intersection. Fantastic, fleeting geometrical patterns flickered in and out of existence as the glowing grids meshed and unmeshed; and the man-apes watched, mesmerized captives of the shining crystal.

They could never guess that their minds were being probed, their bodies mapped, their reactions studied, their potentials evaluated. At first, the whole tribe remained half crouching in a motionless tableau, as if frozen into stone. Then the man-ape nearest to the slab suddenly came to life.

He did not move from his position, but his body lost its trancelike rigidity and became animated as if it were a puppet controlled by invisible strings. The head turned this way and that; the mouth silently opened and closed; the hands clenched and unclenched. Then he bent down, snapped off a long stalk of grass, and attempted to tie it into a knot with clumsy fingers.

He seemed to be a thing possessed, struggling against some spirit or demon who had taken over control of his body. He was panting for breath, and his eyes were full of terror as he tried to force his fingers to make movements more complex than any that they had ever attempted before.

Despite all his efforts, he succeeded only in breaking the stalk into pieces. As the fragments fell to the ground, the controlling influence left him, and he froze once more into immobility.

Another man-ape came to life, and went through the same routine. This was a younger, more adaptable specimen; it succeeded where the older one had failed. On the planet Earth, the first crude knot had been tied.

Others did stranger and still more pointless things. Some held their hands out at arm's length, and tried to touch their fingertips together - first with both eyes open, then with one closed. Some were made to stare at ruled patterns in the crystal, which became more and more finely divided until the lines had merged into a gray blur. And all heard single pure sounds, of varying pitch, that swiftly sank below the level of hearing.

When Moon-Watcher's turn came, he felt very little fear. His main sensation was a dull resentment, as his muscles twitched and his limbs moved at commands that were not wholly his own. Without knowing why, he bent down and picked up a small stone. When he straightened up, he saw that there was a new image in the crystal slab.

The grids and the moving, dancing patterns had gone. Instead, there was a series of concentric circles, surrounding a small black disk. Obeying the silent orders in his brain, he pitched the stone with a clumsy, overarm throw. It missed the target by several feet.

Try again, said the command. He searched around until he had found another pebble. This time it hit the slab with a ringing, bell-like tone. He was still a long way off, but his aim was improving. At the fourth attempt, he was only inches from the central bull's-eye. A feeling of indescribable pleasure, almost sexual in its intensity, flooded his mind. Then the control relaxed; he felt no impulse to do anything, except to stand and wait.

One by one, every member of the tribe was briefly possessed. Some succeeded, but most failed at the tasks they had been set, and all were appropriately rewarded by spasms of pleasure or of pain.

Now there was only a uniform featureless glow in the great slab, so that it stood like a block of light superimposed on the surrounding darkness. As if waking from a sleep, the man-apes shook their heads, and presently began to move along the trail to their place of shelter. They did not look back, or wonder at the strange light that was guiding them to their homes - and to a future unknown, as yet, even to the stars.

3 - Academy

Moon-Watcher and his companions had no recollection of what they had seen, after the crystal had ceased to cast its hypnotic spell over their minds and to experiment with their bodies. The next day, as they went out to forage, they passed it with scarcely a second thought; it was now part of the disregarded background of their lives. They could not eat it, and it could not eat them; therefore it was not important.

Down at the river, the Others made their usual ineffectual threats. Their leader, a one-eared man-ape of Moon-Watcher's size and age, but in poorer condition, even made a brief foray toward the tribe's territory, screaming loudly and waving his arms in an attempt to scare the opposition and to bolster his own courage.

The water of the stream was nowhere more than a foot deep, but the farther One-Ear moved out into it, the more uncertain and unhappy he became. Very soon he slowed to a halt, and then moved back, with exaggerated dignity, to join his companions.

Otherwise, there was no change in the normal routine. The tribe gathered just enough nourishment to survive for another day, and no one died.

And that night, the crystal slab was still waiting; surrounded by its pulsing aura of light and sound. The program it had contrived, however, was now subtly different.

Some, of the man-apes it ignored completely, as if it was concentrating on the most promising subjects.

One of them was Moon-Watcher; once again he felt inquisitive tendrils creeping down the unused byways of his brain. And presently, he began to see visions. They might have been within the crystal block; they might have been wholly inside his mind. In any event, to Moon-Watcher they were completely real. Yet somehow the usual automatic impulse to drive off invaders of his territory had been lulled into quiescence.

He was looking at a peaceful family group, differing in only one respect from the scenes he knew. The male, female, and two infants that had mysteriously appeared before him were gorged and replete, with sleek and glossy pelts - and this was a condition of life that Moon-Watcher had never imagined. Unconsciously, he felt his own protruding ribs; the ribs of these creatures were hidden in rolls of fat. From time to time they stirred lazily, as they lolled at ease near the entrance of a cave, apparently at peace with the world. Occasionally; the big male emitted a monumental burp of contentment.

There was no other activity, and after five minutes the scene suddenly faded out. The crystal was no more than a glimmering outline in the darkness; Moon-Watcher shook himself as if awaking from a dream, abruptly realized where he was, and led the tribe back to the caves.

He had no conscious memory of what he had seen; but that night, as he sat brooding at the entrance of his lair, his ears attuned to the noises of the

world around him, Moon-Watcher felt the first faint twinges of a new and potent emotion. It was a vague and diffuse sense of envy - of dissatisfaction with his life. He had no idea of its cause, still less of its cure; but discontent had come into his soul, and he had taken one small step toward humanity.

Night after night, the spectacle of those four plump man-apes was repeated, until it had become a source of fascinated exasperation, serving to increase Moon-Watcher's eternal, gnawing hunger. The evidence of his eyes could not have produced this effect; it needed psychological reinforcement. There were gaps in Moon-Watcher's life now that he would never remember, when the very atoms of his simple brain were being twisted into new patterns. If he survived, those patterns would become eternal, for his genes would pass them on to future generations.

It was a slow, tedious business, but the crystal monolith was patient. Neither it, nor its replicas scattered across half the globe, expected to succeed with all the scores of groups involved in the experiment. A hundred failures would not matter, when a single success could change the destiny of the world.

By the time of the next new moon, the tribe had seen one birth and two deaths. One of these had been due to starvation; the other had occurred during the nightly ritual, when a man-ape had suddenly collapsed while attempting to tap two pieces of stone delicately together. At once, the crystal had darkened, and the tribe had been released from the spell. But the fallen man-ape had not moved; and by the morning, of course, the body was gone.

There had been no performance the next night; the crystal was still analyzing its mistake. The tribe streamed past it through the gathering dusk, ignoring its presence completely. The night after, it was ready for them again. The four plump man-apes were still there, and now they were doing extraordinary things. Moon-Watcher began to tremble uncontrollably; he felt as if his brain would burst, and wanted to turn away

his eyes. But that remorseless mental control would not relax its grip; he was compelled to follow the lesson to the end, though all his instincts revolted against it.

Those instincts had served his ancestors well, in the days of warm rains and lush fertility, when food was to be had everywhere for the plucking. Now times had changed, and the inherited wisdom of the past had become folly. The man-apes must adapt, or they must die - like the greater beasts who had gone before them, and whose bones now lay sealed within the limestone hills.

So Moon-Watcher stared at the crystal monolith with unblinking eyes, while his brain lay open to its still uncertain manipulations. Often he felt nausea, but always he felt hunger; and from time to time his hands clenched unconsciously in the patterns that would determine his new way of life.

As the line of warthogs moved snuffling and grunting across the trail, Moon-Watcher came to a sudden halt. Pigs and man-apes had always ignored each other, for there was no conflict of interest between them. Like most animals that did not compete for the same food, they merely kept out of each other's way.

Yet now Moon-Watcher stood looking at them, wavering back and forth uncertainly as he was buffeted by impulses which he could not understand. Then, as if in a dream, he started searching the ground - though for what, he could not have explained even if he had had the power of speech. He would recognize it when he saw it.

It was a heavy, pointed stone about six inches long, and though it did not fit his hand perfectly, it would do. As he swung his hand around, puzzled by its suddenly increased weight, he felt a pleasing sense of power and authority. He started to move toward the nearest pig.

It was a young and foolish animal, even by the undemanding standards of warthog intelligence. Though it observed him out of the corner of its eye, it did not take him seriously until much too late. Why should it suspect these harmless creatures of any evil intent? It went on rooting up the grass until Moon-Watcher's stone hammer obliterated its dim consciousness. The remainder of the herd continued grazing unalarmed, for the murder had been swift and silent.

All the other man-apes in the group had stopped to watch, and now they crowded round Moon-Watcher and his victim with admiring wonder. Presently one of them picked up the blood-stained weapon, and began to pound the dead pig. Others joined in with any sticks and stones that they could gather, until their target began a messy disintegration.

Then they became bored; some wandered off, while others stood hesitantly around the unrecognizable corpse - the future of a world waiting upon their decision. It was a surprisingly long time before one of the nursing females began to lick the gory stone she was holding in her paws.

And it was longer still before Moon-Watcher, despite all that he had been shown, really understood that he need never be hungry again.

4 - The Leopard

The tools they had been programmed to use were simple enough, yet they could change this world and make the man-apes its masters. The most primitive was the hand-held stone, that multiplied manyfold the power of a blow. Then there was the bone club, that lengthened the reach and could provide a buffer against the fangs or claws of angry animals. With these weapons, the limitless food that roamed the savannas was theirs to take.

But they needed other aids, for their teeth and nails could not readily dismember anything larger than a rabbit, Luckily, Nature had provided the perfect tools, requiring only the wit to pick them up; First there was a crude but very efficient knife or saw, of a model that would serve well for the next three million years. It was simply the lower jawbone of an antelope, with the teeth still in place; there would be no substantial improvement until the coming of steel. Then there was an awl or dagger in the form of a gazelle horn, and finally a scraping tool made from the complete jaw of almost any small animal.

The stone club, the toothed saw, the horn dagger, the bone scraper - these were the marvelous inventions which the man-apes needed in order to survive. Soon they would recognize them for the symbols of power that they were, but many months must pass before their clumsy fingers had acquired the skill - or the will - to use them.

Perhaps, given time, they might by their own efforts have come to the awesome and brilliant concept of using natural weapons as artificial tools. But the odds were all against them, and even now there were endless opportunities for failure in the ages that lay ahead.

The man-apes had been given their first chance. There would be no second one; the future was, very literally, in their own hands.

Moons waxed and waned; babies were born and sometimes lived; feeble, toothless thirty-year-olds died; the leopard took its toll in the night; the Others threatened daily across the river - and the tribe prospered. In the course of a single year, Moon-Watcher and his companions had changed almost beyond recognition.

They had learned their lessons well; now they could handle all the tools that had been revealed to them. The very memory of hunger was fading

from their minds; and though the warthogs were becoming shy, there were gazelles and antelopes and zebras in countless thousands on the plains. All these animals, and others, had fallen prey to the apprentice hunters.

Now that they were no longer half-numbed with starvation, they had time both for leisure and for the first rudiments of thought. Their new way of life was now casually accepted, and they did not associate it in any way with the monolith still standing beside the trail to the river. If they had ever stopped to consider the matter, they might have boasted that they had brought about their improved status by their own efforts; in fact, they had already forgotten any other mode of existence.

But no Utopia is perfect, and this one had two blemishes. The first was the marauding leopard, whose passion for man-apes seemed to have grown even stronger now that they were better nourished. The second was the tribe across the river; for somehow the Others had survived, and had stubbornly refused to die of starvation.

The leopard problem was resolved partly by chance, partly owing to a serious - indeed almost fatal - error on Moon-Watcher's part. Yet at the time his idea had seemed such a brilliant one that he had danced with joy, and perhaps he could hardly be blamed for overlooking the consequences.

The tribe still experienced occasional bad days, though these no longer threatened its very survival. Toward dusk, it had failed to make a kill; the home caves were already in sight as Moon-Watcher led his tired and disgruntled companions back to shelter. And there, on their very threshold, they found one of nature's rare bonanzas. A full-grown antelope was lying by the trail. Its foreleg was broken, but it still had plenty of fight in it, and the circling jackals gave its daggerlike horns a respectful berth. They could afford to wait; they knew that they had only to bide their time. But they had forgotten about the competition, and retreated with angry snarls when the man-apes arrived.

They too circled warily, keeping beyond the range of those dangerous horns; then they moved to the attack with clubs and stones.

It was not a very effective or coordinated attack; by the time the wretched beast had been given its quietus the light had almost gone - and the jackals were regaining their courage. Moon-Watcher, torn between fear and hunger, slowly realized that all this effort might have been in vain. It was too dangerous to stay here any longer.

Then, not for the first or the last time, he proved himself a genius. With an immense effort of imagination, he visualized the dead antelope - in the safety of his own cave. He began to drag it toward the cliff face; presently, the others understood his intentions, and began to help him.

If he had known how difficult the task would be, he would never have attempted it. Only his great strength, and the agility inherited from his arboreal ancestors allowed him to haul the carcass up the steep slope. Several times, weeping with frustration, he almost abandoned his prize, but a stubbornness as deep-seated as his hunger drove him on. Sometimes the others helped him, sometimes they hindered; more often, they merely got in the way. But finally it was done; the battered antelope was dragged over the lip of the cave, as the last hues of sunlight faded from the sky; and the feasting began.

Hours later, gorged to repletion, Moon-Watcher awoke. Not knowing why, he sat up in the darkness among the sprawled bodies of his equally satiated companions, and strained his ears into the night.

There was no sound except the heavy breathing around him; the whole world seemed asleep. The rocks beyond the mouth of the cave were pale as bone in the brilliant light from the moon, now high overhead. Any thought of danger seemed infinitely remote.

Then, from a long way off, came the sound of a falling pebble. Fearful, yet inquisitive, Moon-Watcher crawled out onto the ledge of the cave and peered down the face of the cliff.

What he saw left him so paralyzed with fright that for long seconds he was unable to move. Only twenty feet below, two gleaming golden eyes were staring straight up at him; they held him so hypnotized with fear that he was scarcely aware of the lithe, streaked body behind them, flowing smoothly and silently from rock to rock. Never before had the leopard climbed so high. It had ignored the lower caves, though it must have been well aware of their inhabitants. Now it was after other game; it was following the spoor of blood, up the moon-washed face of the cliff.

Seconds later, the night was made hideous by the shrieks of alarm from the man-apes in the cave above. The leopard gave a snarl of fury as it realized that it had lost the element of surprise. But it did not check its advance, for it knew that it had nothing to fear.

It reached the ledge, and rested for a moment on the narrow open space. The scent of blood was all around, filling its fierce and tiny mind with one overwhelming desire. Without hesitation, it padded silently into the cave.

And here it made its first error, for as it moved out of the moonlight even its superbly night-adapted eyes were at a momentary disadvantage. The man-apes could see it, partly silhouetted against the opening of the cave, more clearly than it could see them. They were terrified, but they were no longer utterly helpless.

Snarling and lashing its tail in arrogant confidence, the leopard advanced in search of the tender food that it craved. Had it met its prey in the open, it would have had no problems; but now that the man-apes were trapped, desperation had given them the courage to attempt the impossible. And for the first time they had the means to achieve it.

The leopard knew that something was wrong when it felt a stunning blow on its head. It lashed out with its forepaw, and heard a shriek of agony as its claws slashed through soft flesh. Then there was a piercing pain as something sharp drove into its flanks - once, twice, and yet a third time. It whirled around to strike at the shadows screaming and dancing on all sides.

Again there was a violent blow as something caught it across the snout. Its teeth snapped on a white, moving blur - only to grate uselessly upon dead bone. And now - in a final, unbelievable indignity - its tail was being dragged out by the roots.

It whirled around, throwing its insanely daring tormentor against the wall of the cave. Yet whatever it did, it could not escape the rain of blows, inflicted on it by crude weapons wielded by clumsy but powerful hands. Its snarls ran the gamut from pain to alarm, from alarm to outright terror. The implacable hunter was now the victim, and was desperately trying to retreat.

And then it made its second mistake, for in its surprise and fright it had forgotten where it was. Or perhaps it had been dazed or blinded by the blows rained on its head; whatever the case, it bolted abruptly from the cave. There was a horrible screech as it went toppling out into space. Ages later, it seemed, there came a thud as it crashed into an outcropping halfway down the cliff; thereafter, the only sound was the sliding of loose stones, which quickly died away into the night.

For a long time, intoxicated by victory, Moon-Watcher stood dancing and gibbering at the entrance of the cave. He rightly sensed that his whole world had changed and that he was no longer a powerless victim of the forces around him.

Then he went back into the cave and, for the first time in his life, had an unbroken night's sleep.

In the morning, they I found the body of the leopard at the foot of the cliff. Even in death, it was some time before anyone dared to approach the vanquished monster, but presently they closed in upon it, with their bone knives and saws.

It was very hard work, and they did no hunting that day.

5 - Encounter in the Dawn

As he led the tribe down to the river in the dim light of dawn, Moon-Watcher paused uncertainly at a familiar spot. Something, he knew, was missing; but what it was, he could not remember. He wasted no mental effort on the problem, for this morning he had more important matters on his mind.

Like thunder and lightning and clouds and eclipses, the great block of crystal had departed as mysteriously as it had come. Having vanished into the nonexistent past, it never troubled Moon-Watcher's thoughts again.

He would never know what it had done to him; and none of his companions wondered, as they gathered round him in the morning mist, why he had paused for a moment here on the way to the river.

From their side of the stream, in the never-violated safety of their own territory, the Others first saw Moon-Watcher and a dozen males of his tribe as a moving frieze against the dawn sky. At once they began to scream their daily challenge; but this time, there was no answer.

Steadily, purposefully - above all, silently - Moon-Watcher and his band descended the low hillock that overlooked the river; and as they approached, the Others became suddenly quiet. Their ritual rage ebbed away, to be replaced by a mounting fear. They were dimly aware that something had happened, and that this encounter was unlike all those that had ever gone before.

The bone clubs and knives that Moon-Watcher's group carried did not alarm them, for they did not understand their purpose. They only knew that their rivals' movements were now imbued with determination, and with menace.

The party stopped at the water's edge, and for a moment the Others' courage revived. Led by One-Ear, they halfheartedly resumed their battle chant. It lasted only a few seconds before a vision of terror struck them dumb.

Moon-Watcher raised his arms high into the air, revealing the burden that until now had been concealed by the hirsute bodies of his companions. He was holding a stout branch, and impaled upon it was the bloody head of the leopard. The mouth had been jammed open with a stick, and the great fangs gleamed a ghastly white in the first rays of the rising sun.

Most of the Others were too paralyzed with fright to move; but some began a slow, stumbling retreat. That was all the encouragement that Moon-Watcher needed. Still holding the mangled trophy above his head, he started to cross the stream. After a moment's hesitation, his companions splashed after him.

When Moon-Watcher reached the far side, One-Ear was still standing his ground. Perhaps he was too brave or too stupid to run; perhaps he could not really believe that this outrage was actually happening. Coward

or hero, it made no difference in the end, as the frozen snarl of death came crashing down upon his uncomprehending head.

Shrieking with fright, the Others scattered into the bush; but presently they would return, and soon they would forget their lost leader.

For a few seconds Moon-Watcher stood uncertainly above his new victim, trying to grasp the strange and wonderful fact that the dead leopard could kill again. Now he was master of the world, and he was not quite sure what to do next.

But he would think of something.

6 - Ascent of Man

A new animal was abroad on the planet, spreading slowly out from the African heartland. It was still so rare that a hasty census might have overlooked it, among the teeming billions of creatures roving over land and sea. There was no evidence, as yet, that it would prosper or even survive: on this world where so many mightier beasts had passed away, its fate still wavered in the balance.

In the hundred thousand years since the crystals had descended upon Africa, the man-apes had invented nothing. But they had started to change, and had developed skills which no other animal possessed. Their bone clubs had increased their reach and multiplied their strength; they were no longer defenseless against the predators with whom they had to compete. The smaller carnivores they could drive away from their own kills; the larger ones they could at least discourage, and sometimes put to flight.

Their massive teeth were growing smaller, for they were no longer essential. The sharp-edged stones that could be used to dig out roots, or to cut and saw through tough flesh or fiber, had begun to replace them, with immeasurable consequences. No longer were the man-apes faced with starvation when their teeth became damaged or worn; even the crudest tools could add many years to their lives. And as their fangs diminished, the shape of their face started to alter; the snout receded, the massive jaw became more delicate, the mouth able to make more subtle sounds. Speech was still a million years away, but the first steps toward it had been taken.

And then the world began to change. In four great waves, with two hundred thousand years between their crests, the Ice Ages swept by, leaving their mark on all the globe. Outside the tropics, the glaciers slew those who had prematurely left their ancestral home; and everywhere they winnowed out the creatures who could not adapt.

When the ice had passed, so had much of the planet's early life - including the man-apes. But, unlike so many others, they had left descendants; they had not merely become extinct - they had been transformed. The toolmakers had been remade by their own tools.

For in using clubs and flints, their hands had developed a dexterity found nowhere else in the animal kingdom, permitting them to make still better tools, which in turn had developed their limbs and brains yet further. It was an accelerating, cumulative process; and at its end was Man.

The first true men had tools and weapons only a little better than those of their ancestors a million years earlier, but they could use them with far greater skill.

And somewhere in the shadowy centuries that had gone before they had invented the most essential tool of all, though it could be neither seen nor touched. They had learned to speak, and so had won their first great victory over Time. Now the knowledge of one generation could be handed

on to the next, so that each age could profit from those that had gone before.

Unlike the animals, who knew only the present, Man had acquired a past; and he was beginning to grope toward a future.

He was also learning to harness the forces of nature; with the taming of fire, he had laid the foundations of technology and left his animal origins far behind. Stone gave way to bronze, and then to iron. Hunting was succeeded by agriculture. The tribe grew into the village, the village into the town. Speech became eternal, thanks to certain marks on stone and clay and papyrus. Presently he invented philosophy, and religion. And he peopled the sky, not altogether inaccurately, with gods.

As his body became more and more defenseless, so his means of offense became steadily more frightful. With stone and bronze and iron and steel he had run the gamut of everything that could pierce and slash, and quite early in time he had learned how to strike down his victims from a distance. The spear, the bow, the gun, and finally the guided missile had given him weapons of infinite range and all but infinite power.

Without those weapons, often though he had used them against himself, Man would never have conquered his world. Into them he had put his heart and soul, and for ages they had served him well.

But now, as long as they existed, he was living on borrowed time.



TMA-1

7 - Special Flight

No matter how many times you left Earth, Dr. Heywood Floyd told himself, the excitement never really palled. He had been to Mars once, to the Moon three times, and to the various space stations more often than he could remember. Yet as the moment of takeoff approached, he was conscious of a rising tension, a feeling of wonder and awe - yes; and of nervousness - which put him on the same level as any Earthlubber about to receive his first baptism of space.

The jet that had rushed him here from Washington, after that midnight briefing with the President, was now dropping down toward one of the most familiar, yet most exciting, landscapes in all the world. There lay the first two generations of the Space Age, spanning twenty miles of the Florida coast to the south, outlined by winking red warning lights, were the giant gantries of the Saturns and Neptunes, that had set men on the path to the planets, and had now passed into history. Near the horizon, a gleaming silver tower bathed in floodlights, stood the last of the Saturn V's, for almost twenty years a national monument and place of pilgrimage. Not far away, looming against the sky like a man-made mountain, was the incredible bulk of the Vehicle Assembly Building, still the largest single structure on Earth.

But these things now belonged to the past, and he was flying toward the future. As they banked, Dr. Floyd could see below him a maze of buildings, then a great airstrip, then a broad, dead-straight scar across the fiat Florida landscape - the multiple rails of a giant launch-lug track. At its end, surrounded by vehicles and gantries, a spaceplane lay gleaming in a pool of light, being prepared for its leap to the stars. In a sudden failure of perspective, brought on by his swift changes of speed and height, it

seemed to Floyd that he was looking down on a small silver moth, caught in the beam of a flashlight.

Then the tiny, scurrying figures on the ground brought home to him the real size of the spacecraft; it must have been two hundred feet across the narrow V of its wings.

And that enormous vehicle, Floyd told himself with some incredulity - yet also with some pride - is waiting for me. As far as he knew, it was the first time that an entire mission had been set up to take a single man to the Moon.

Though, it was two o'clock in the morning, a group of reporters and cameramen intercepted him on his way to the floodlit Orion III spacecraft. He knew several of them by sight, for as Chairman of the National Council of Astronautics, the news conference was part of his way of life. This was neither the time nor the place for one, and he had nothing to say; but it was important not to offend the gentlemen of the communications media.

"Dr. Floyd? I'm Jim Forster of Associated News. Could you give us a few words about this flight of yours?"

"I'm very sorry - I can't say anything."

"But you did meet with the President earlier this evening?" asked a familiar voice.

"Oh - hello, Mike. I'm afraid you've been dragged out of bed for nothing. Definitely no comment."

"Can you at least confirm or deny that some kind of epidemic has broken out on the Moon?" a TV reporter asked, managing to jog alongside and keep Floyd properly framed in his miniature TV camera.

"Sorry," said Floyd, shaking his head.

"What about the quarantine?" asked another reporter. "How long will it be kept on?"

"Still no comment."

"Dr. Floyd," demanded a very short and determined lady of the press, "what possible justification can there be for this total blackout of news from the Moon? Has it anything to do with the political situation?"

"What political situation?" Floyd asked dryly. There was a sprinkle of laughter, and someone called, "Have a good trip, Doctor!" as he made his way into the sanctuary of the boarding gantry.

As long, as he could remember, it had been not a "situation" so much as a permanent crisis. Since the 1970s, the world had been dominated by two problems which, ironically, tended to cancel each other out.

Though birth control was cheap, reliable, and endorsed by all the main religions, it had come too late; the population of the world was now six billion - a third of them in the Chinese Empire. Laws had even been passed in some authoritarian societies limiting families to two children, but their enforcement had proved impracticable. As a result, food was short in every country; even the United States had meatless days, and widespread famine was predicted within fifteen years, despite heroic efforts to farm the sea and to develop synthetic foods.

With the need for international cooperation more urgent than ever, there were still as many frontiers as in any earlier age. In a million years, the human race had lost few of its aggressive instincts; along symbolic lines visible only to politicians, the thirty-eight nuclear powers watched one another with belligerent anxiety. Among them, they possessed sufficient megatonnage to remove the entire surface crust of the planet. Although

there had been - miraculously - no use of atomic weapons, this situation could hardly last forever.

And now, for their own inscrutable reasons, the Chinese were offering to the smallest have-not nations a complete nuclear capability of fifty warheads and delivery systems. The cost was under \$200,000,000, and easy terms could be arranged.

Perhaps they were only trying to shore up their sagging economy, by turning obsolete weapons systems into hard cash, as some observers had suggested. Or perhaps they had discovered methods of warfare so advanced that they no longer had need of such toys; there had been talk of radio-hypnosis from satellite transmitters, compulsion viruses, and blackmail by synthetic diseases for which they alone possessed the antidote.

These charming ideas were almost certainly propaganda or pure fantasy, but it was not safe to discount any of them. Every time Floyd took off from Earth, he wondered if it would still be there when the time came to return.

The trim stewardess greeted him as he entered the cabin. "Good morning, Dr. Floyd. I'm Miss Simmons - I'd like to welcome you aboard on behalf of Captain Tynes and our copilot, First Officer Ballard."

"Thank you," said Floyd with a smile, wondering why stewardesses always had to sound like robot tour guides.

"Takeoff's in five minutes," she said, gesturing into the empty twenty-passenger cabin. "You can take any seat you want, but Captain Tynes recommends the forward window seat on the left, if you want to watch the docking operations."

"I'll do that," he answered, moving toward the preferred seat. The stewardess fussed over him awhile and then moved to her cubicle at the rear of the cabin.

Floyd settled down in his seat, adjusted the safety harness around waist and shoulders, and strapped his briefcase to the adjacent seat. A moment later, the loudspeaker came on with a soft popping noise. "Good morning," said Miss Simmons' voice. "This is Special Flight 3, Kennedy to Space Station One."

She was determined, it seemed, to go through the full routine for her solitary passenger, and Floyd could not resist a smile as she continued inexorably.

"Our transit time will be fifty-five minutes. Maximum acceleration will be two-gee, and we will be weightless for thirty minutes. Please do not leave your seat until the safety sign is lit."

Floyd looked over his shoulder and called, "Thank you." He caught a glimpse of a slightly embarrassed but charming smile.

He leaned back into his seat and relaxed. This trip, he calculated, would cost the taxpayers slightly over a million dollars. If it was not justified, he would be out of his job; but he could always go back to the university and to his interrupted studies of planetary formation.

"Auto-countdown procedures all Go," the captain's voice said over the speaker with the soothing singsong used in RT chat. "Lift-off in one minute."

As always, it seemed more like an hour. Floyd became acutely aware of the gigantic forces coiled up around him, waiting to be released. In the fuel tanks of the two spacecraft, and in the power storage system of the launching track, was pent up the energy of a nuclear bomb. And it would all be used to take him a mere two hundred miles from Earth.

There was none of the old-fashioned FIVE-FOUR-THREE-TWO-ONE-ZERO business, so tough on the human nervous system.

"Launching in fifteen seconds. You will be more comfortable if you start breathing deeply."

That was good psychology, and good physiology.

Floyd felt himself well charged with oxygen, and ready to tackle anything, when the launching track began to sling its thousand-ton payload out over the Atlantic.

It was hard to tell when they lifted from the track and became airborne, but when the roar of the rockets suddenly doubled its fury, and Floyd found himself sinking deeper and deeper into the cushions of his seat, he knew that the first-stage engines had taken over. He wished he could look out of the window, but it was an effort even to turn his head. Yet there was no discomfort; indeed, the pressure of acceleration and the overwhelming thunder of the motors produced an extraordinary euphoria. His ears ringing, the blood pounding in his veins, Floyd felt more alive than he had for years. He was young again, he wanted to sing aloud - which was certainly safe, for no one could possibly hear him.

The mood passed swiftly, as he suddenly realized that he was leaving Earth, and everything he had ever loved. Down there were his three children, motherless since his wife had taken that fatal flight to Europe ten years ago. (Ten years? Impossible! Yet it was so...) Perhaps, for their sake, he should have remarried.

He had almost lost sense of time when the pressure and the noise abruptly slackened, and the cabin speaker announced: "Preparing to separate from lower stage. Here we go."

There was a slight jolt; and suddenly Floyd recalled a quotation of Leonardo da Vinci's which he had once seen displayed in a NASA office:

The Great Bird will take its flight on the back of the great bird, bringing glory to the nest where it was born.

Well, the Great Bird was flying now, beyond all the dreams of da Vinci, and its exhausted companion was winging back to earth. In a ten-thousand-mile arc, the empty lower stage would glide down into the atmosphere, trading speed for distance as it homed on Kennedy. In a few hours, serviced and refueled, it would be ready again to lift another companion toward the shining silence with it could never reach.

Now, thought Floyd, we are on our own, more than halfway to orbit. When the acceleration came on again, as the upper stage rockets fired, the thrust was much more gentle: indeed, he felt no more than normal gravity. But it would have been impossible to walk, since "Up" was straight toward the front of the cabin. If he had been foolish enough to leave his seat, he would have crashed at once against the rear wall.

This effect was a little disconcerting, for it seemed that the ship was standing on its tail. To Floyd, who was at the very front of the cabin, all the seats appeared to be fixed on a wall topping vertically beneath him. He was doing his best to ignore this uncomfortable illusion when dawn exploded outside the ship.

In seconds, they shot through veils of crimson and pink and gold and blue into the piercing white of day.

Though the windows were heavily tinted to reduce the glare, the probing beams of sunlight that now slowly swept across the cabin left

Floyd half-blinded for several minutes. He was in space, yet there was no question of being able to see the stars.

He shielded his eyes with his hands and tried to peer through the window beside him. Out there the swept-back wing of the ship was blazing like white-hot metal in the reflected sunlight; there was utter darkness all around it, and that darkness must be full of stars - but it was impossible to see them.

Weight was slowly ebbing; the rockets were being throttled back as the ship eased itself into orbit. The thunder of the engines dropped to a muted roar, then a gentle hiss, then died into silence. If it had not been for the restraining straps, Floyd would have floated out of his seat; his stomach felt as if it was going to do so anyway. He hoped that the pills he had been given half an hour and ten thousand miles ago would perform as per specifications. He had been spacesick just once in his career, and that was much too often.

The pilot's voice was firm and confident as it came over the cabin speaker. "Please observe all Zero-gee regulations. We will be docking at Space Station One in forty-five minutes."

The stewardess came walking up the narrow corridor to the right of the closely spaced seats. There was a slight buoyancy about her steps, and her feet came away from the floor reluctantly as if entangled in glue. She was keeping to the bright yellow band of Velcro carpeting that ran the full length of the floor - and of the ceiling. The carpet, and the soles of her sandals, were covered with myriads of tiny hooks, so that they clung together like burrs. This trick of walking in free fall was immensely reassuring to disoriented passengers.

"Would you like some coffee or tea, Dr. Floyd?" she asked cheerfully.

"No thank you," he smiled. He always felt like a baby when he had to suck at one of those plastic drinking tubes.

The stewardess was still hovering anxiously around him as he popped open his briefcase and prepared to remove his papers.

"Dr. Floyd, may I ask you a question?"

"Certainly," he answered, looking up over his glasses. "My fiancé is a geologist at Clavius," said Miss Simmons, measuring her words carefully, "and I haven't heard from him for over a week."

"I'm sorry to hear that; maybe he's away from his base, and out of touch."

She shook her head. "He always tells me when that's going to happen. And you can imagine how worried I am - with all these rumors. Is it really true about an epidemic on the Moon?"

"If it is, there's no cause for alarm.. Remember, there was a quarantine back in '98, over that mutated flu virus. A lot of people were sick - but no one died, And that's really all I can say," he concluded firmly.

Miss Simmons smiled pleasantly and straightened up. "Well, thank you anyway, Doctor. I'm sorry to have bothered you."

"No bother at all," he said gallantly, but not very accurately. Then he buried himself in his endless technical reports, in a desperate last-minute assault on the usual backlog;

He would have no time for reading when he got to the Moon.

8 - Orbital Rendezvous

Half an hour later the pilot announced: "We make contact in ten minutes. Please check your seat harness."

Floyd obeyed, and put away his papers. It was asking for trouble to read during the celestial juggling act which took place during the last 300 miles; best to close one's eyes and relax while the spacecraft was nudged back and forth with brief bursts of rocket power.

A few minutes later he caught his first glimpse of Space Station One, only a few miles away. The sunlight glinted and sparkled from the polished metal surfaces of the slowly revolving, three-hundred-yard-diameter disk. Not far away, drifting in the same orbit, was a sweptback Titov-V spaceplane, and close to that an almost spherical Aries-1B, the workhorse of space, with the four stubby legs of its lunar-landing shock absorbers jutting from one side.

The Orion III spacecraft was descending from a higher orbit, which brought the Earth into spectacular view behind the Station. From his altitude of 200 miles, Floyd could see much of Africa and the Atlantic Ocean. There was considerable cloud cover, but he could still detect the blue-green outlines of the Gold Coast.

The central axis of the Space Station, with its docking arms extended, was now slowly swimming toward them. Unlike the structure from which it sprang, it was not rotating - or, rather, it was running in reverse at a rate which exactly countered the Station's own spin. Thus a visiting spacecraft could be coupled to it, for the transfer of personnel or cargo, without being whirled disastrously around.

With the softest of thuds, ship and Station made contact. There were metallic, scratching noises from outside, then the brief hissing of air as pressures equalized.

A few seconds later the airlock door opened, and a man wearing the light, close-fitting slacks and short-sleeved shirt which was almost the uniform of Space Station personnel came into the cabin.

"Pleased to meet you, Dr. Floyd. I'm Nick Miller, Station Security; I'm to look after you until the shuttle leaves."

They shook hands, then Floyd smiled at the stewardess and said: "Please give my compliments to Captain Tynes, and thank him for the smooth ride. Perhaps I'll see you on the way home."

Very cautiously - it was more than a year since he had last been weightless and it would be some time before he regained his spacelegs - he hauled himself hand over hand through the airlock and into the large, circular chamber at the axis of the Space Station. It was a heavily padded room, its walls covered with recessed handholds; Floyd gripped one of these firmly while the whole chamber started to rotate, until it matched the spin of the Station.

As it gained speed, faint and ghostly gravitational fingers began to clutch at him, and he drifted slowly toward the circular wall. Now he was standing, swaying back and forth gently like seaweed in the surge of the tide, on what had magically become a curving floor. The centrifugal force of the Station's spin had taken hold of him; it was very feeble here, so near the axis, but would increase steadily as he moved outward.

From the central transit chamber he followed Miller down a curving stair. At first his weight was so slight that he had almost to force himself downward by holding on to the handrail. Not until he reached the passenger lounge, on the outer skin of the great revolving disk, had he acquired enough weight to move around almost normally.

The lounge had been redecorated since his last visit, and had acquired several new facilities. Besides the usual chairs, small tables, restaurant, and post office there were now a barber shop, drugstore, movie theater and a souvenir shop selling photographs and slides of lunar and planetary landscapes, guaranteed genuine pieces of Luniks, Rangers, and Surveyors, all neatly mounted in plastic, and exorbitantly priced.

"Can I get you anything while we're waiting?" Miller asked. "We board in about thirty minutes?"

"I could do with a cup of black coffee - two lumps - and I'd like to call Earth."

"Right, Doctor - I'll get the coffee - the phones are over there."

The picturesque booths were only a few yards from a barrier with two entrances labeled WELCOME TO THE U.S. SECTION and WELCOME TO THE SOVIET SECTION.

Beneath these were notices which read, in English, Russian, and Chinese, French, German, and Spanish.

PLEASE HAVE READY YOUR:

Passport

Visa

Medical Certificate

Transportation Permit

Weight Declaration

There was a rather pleasant symbolism about the fact that as soon as they had passed through the barriers, in either direction, passengers were free to mix again. The division was purely for administrative purposes.

Floyd, after checking that the Area Code for the United States was still 81, punched his twelve-digit home number, dropped his plastic all-purpose credit card into the pay slot, and was through in thirty seconds.

Washington was still sleeping, for it was several hours to dawn, but he would not disturb anyone. His housekeeper would get the message from the recorder as soon as she awoke.

"Miss Flemming - this is Dr. Floyd. Sorry I had to leave in such a hurry. Would you please call my office and ask them to collect the car - it's at Dulles Airport and the key is with Mr. Bailey, Senior Flight Control Officer. Next, will you call the Chevy Chase Country Club and leave a message for the secretary. I definitely won't be able to play in the tennis tournament next weekend. Give my apologies - I'm afraid they were counting on me. Then call Downtown Electronics and tell them that if the video in my study isn't fixed by - oh, Wednesday - they can take the damn thing back." He paused for breath, and tried to think of any other crises or problems that might arise during the days ahead.

"If you run short of cash, speak to the office; they can get urgent messages to me, but I may be too busy to answer. Give my love to the children, and say I'll be back as soon as I can. Oh, hell - here's someone I don't want to see - I'll call from the Moon if I can - good-bye."

Floyd tried to duck out of the booth, but it was too late; he had already been spotted. Bearing down on him through the Soviet Section exit was Dr. Dimitri Moisevitch, of the U.S.S.R. Academy of Science. Dimitri was one of Floyd's best friends; and for that very reason, he was the last person he wished to talk to, here and now.

9 - Moon Shuttle

The Russian astronomer was tall, slender, and blond, and his unlined face belied his fifty-five years - the last ten of which had been spent building up the giant radio observatory on the far side of the Moon, where two thousand miles of solid rock would shield it from the electronic racket of Earth.

"Why, Heywood," he said, shaking hands firmly. "It's a small universe... How are you - and your charming children?"

"We're fine," Floyd replied warmly, but with a slightly distracted air. "We often talk about the wonderful time you gave us last summer." He was sorry he could not sound more sincere; they really had enjoyed a week's vacation in Odessa with Dimitri during one of the Russian's visits to Earth.

"And you - I suppose you're on your way up?" Dimitri inquired.

"Er, yes - my flight leaves in half an hour," answered Floyd. "Do you know Mr. Miller?"

The Security Officer had now approached, and was standing at a respectful distance holding a plastic cup full of coffee.

"Of course. But please put that down, Mr. Miller. This is Dr. Floyd's last chance to have a civilized drink - let's not waste it. No - I insist."

They followed Dimitri out of the main lounge into the observation section, and soon were sitting at a table under a dim light watching the

moving panorama of the stars. Space Station One revolved once a minute, and the centrifugal force generated by this slow spin produced an artificial gravity equal to the Moon's. This, it had been discovered, was a good compromise between Earth gravity and no gravity at all; moreover, it gave moon-bound passengers a chance to become acclimatized.

Outside the almost invisible windows, Earth and stars marched in a silent procession. At the moment, this side of the Station was tilted away from the sun; otherwise, it would have been impossible to look out, for the lounge would have been blasted with light. Even as it was, the glare of the Earth, filling half the sky, drowned all but the brighter stars.

But Earth was waning, as the Station orbited toward the night side of the planet; in a few minutes it would be a huge black disk, spangled with the lights of cities. And then the sky would belong to the stars.

"Now," said Dimitri, after he had swiftly downed his first drink and was toying with the second, "what's all this about an epidemic in the U.S. Sector? I wanted to go there on this trip. 'No, Professor,' they told me. 'We're very sorry, but there's a strict quarantine until further notice.' I pulled all the strings I could; It was no use. Now you tell me what's happening."

Floyd groaned inwardly. Here we go again, he said. The sooner I'm on that shuttle, headed for the Moon, the happier I'll be.

"The - ah - quarantine is purely a safety precaution," he said cautiously. "We're not even sure it's really necessary, but we don't believe in taking chances."

"But what is the disease - what are the symptoms? Could it be extraterrestrial? Do you want any help from our medical services?"

"I'm sorry, Dimitri - we've been asked not to say anything at the moment. Thanks for the offer, but we can handle the situation."

"Hmm," said Moisevitch, obviously quite unconvinced. "Seems odd to me that you, an astronomer, should be sent up to the Moon to look into an epidemic."

"I'm only an ex-astronomer; it's years since I did any real research. Now I'm a scientific expert; that means I know nothing about absolutely everything."

"Then do you know what TMA-1 means?"

Miller seemed about to choke on his drink, but Floyd was made of sterner stuff. He looked his old friend straight in the eye, and said calmly: "TMA-1? What an odd expression. Where did you hear it?"

"Never mind," retorted the Russian. "You can't fool me. But if you've run into something you can't handle, I hope you don't leave it until too late before you yell for help."

Miller looked meaningfully at his watch.

"Due to board in five minutes, Dr. Floyd," he said. "I think we'd better get moving."

Though he knew that they still had a good twenty minutes, Floyd got up with haste. Too much haste, for he had forgotten the one-sixth of a gravity. He grabbed the table just in time to prevent a takeoff.

"It was fine meeting you, Dimitri," he said, not quite accurately. "Hope you have a good trip down to Earth - I'll give you a call as soon as I'm back."

As they left the lounge, and checked through the U.S. transit barrier, Floyd remarked: "Phew - that was close. Thanks for rescuing me."

"You know, Doctor," said the Security Officer, "I hope he isn't right."

"Right about what?"

"About us running into something we can't handle."

"That," Floyd answered with determination, "is what I intend to find out."

Forty-five minutes later, the Aries-1B lunar carrier pulled away from the Station. There was none of the power and fury of a takeoff from Earth - only an almost inaudible, far-off whistling as the low-thrust plasma jets blasted their electrified streams into space. The gentle push lasted for more than fifteen minutes, and the mild acceleration would not have prevented anyone from moving around the cabin. But when it was over, the ship was no longer bound to Earth, as it had been while it still accompanied the Station. It had broken the bonds of gravity and was now a free and independent planet, circling the sun in an orbit of its own.

The cabin Floyd now had all to himself had been designed for thirty passengers. It was strange, and rather lonely, to see all the empty seats around him, and to have the undivided attention of the steward and stewardess - not to mention pilot, copilot, and two engineers. He doubted that any man in history had ever received such exclusive service, and it was most unlikely that anyone would do so in the future. He recalled the cynical remark of one of the less reputable pontiffs: "Now that we have the papacy, let us enjoy it." Well, he would enjoy this trip, and the euphoria of weightlessness. With the loss of gravity he had - at least for a while - shed most of his cares. Someone had once said that you could be terrified in space, but you could not be worried there. It was perfectly true.

The stewards, it appeared, were determined to make him eat for the whole twenty-five hours of the trip, and he was continually fending off unwanted meals. Eating in zero gravity was no real problem, contrary to the dark forebodings of the early astronauts. He sat at an ordinary table, to

which the plates were clipped, as aboard ship in a rough sea. All the courses had some element of stickiness, so that they would not take off and go wandering round the cabin. Thus a chop would be glued to the plate by a thick sauce, and a salad kept under control by an adhesive dressing. With a little skill and care there were few items that could not be tackled safely; the only things banned were hot soups and excessively crumbly pastries. Drinks of course, were a different matter; all liquids simply had to be kept in plastic squeeze tubes.

A whole generation of research by heroic but unsung volunteers had gone into the design of the washroom, and it was now considered to be more or less foolproof. Floyd investigated it soon after free fall had begun. He found himself in a little cubicle with all the fittings of an ordinary airline toilet, but illuminated with a red light that was very harsh and unpleasant to the eye. A notice printed in prominent letters announced: **MOST IMPORTANT! FOR YOUR OWN COMFORT, PLEASE READ THESE INSTRUCTIONS CAREFULLY!**

Floyd sat down (one still tended to do so, even when weightless) and read the notice several times. When he was sure that there had been no modifications since his last trip, he pressed the START button.

Close at hand, an electric motor began to whirr, and Floyd felt himself moving. As the notice advised him to do, he closed his eyes and waited. After a minute, a bell chimed softly and he looked around.

The light had now changed to a soothing pinkish-white; but, more important, he was under gravity again.

Only the faintest vibration revealed that it was a spurious gravity, caused by the carousel-like spin of the whole toilet compartment. Floyd picked up a piece of soap, and watched it drop in slow motion; he judged that the centrifugal force was about a quarter of a normal gravity. But that was quite enough; it would ensure that everything moved in the right direction, in the one place where this mattered most.

He pressed the STOP FOR EXIT button, and closed his eyes again. Weight slowly ebbed as the rotation ceased, the bell gave a double chime, and the red warning light was back. The door was then locked in the right position to let him glide out into the cabin, where he adhered as quickly as possible to the carpet. He had long ago exhausted the novelty of weightlessness, and was grateful for the Velcro slippers that allowed him to walk almost normally.

There was plenty to occupy his time, even if he did nothing but sit and read. When he tired of official reports and memoranda and minutes, he would plug his foolscap-sized Newspad into the ship's information circuit and scan the latest reports from Earth. One by one he would conjure up the world's major electronic papers; he knew the codes of the more important ones by heart, and had no need to consult the list on the back of his pad. Switching to the display unit's short-term memory, he would hold the front page while he quickly searched the headlines and noted the items that interested him.

Each had its own two-digit reference; when he punched that, the postage-stamp-sized rectangle would expand until it neatly filled the screen and he could read it with comfort. When he had finished, he would flash back to the complete page and select a new subject for detailed examination.

Floyd sometimes wondered if the Newspad, and the fantastic technology behind it, was the last word in man's quest for perfect communications. Here he was, far out in space, speeding away from Earth at thousands of miles an hour, yet in a few milliseconds he could see the headlines of any newspaper he pleased. (That very word "newspaper," of course, was an anachronistic hangover into the age of electronics.) The text was updated automatically on every hour; even if one read only the English versions, one could spend an entire lifetime doing nothing but absorbing the ever-changing flow of information from the news satellites.

It was hard to imagine how the system could be improved or made more convenient. But sooner or later, Floyd guessed, it would pass away, to be replaced by something as unimaginable as the Newspad itself would have been to Caxton or Gutenberg.

There was another thought which a scanning of those tiny electronic headlines often invoked. The more wonderful the means of communication, the more trivial, tawdry, or depressing its contents seemed to be. Accidents, crimes, natural and man-made disasters, threats of conflict, gloomy editorials - these still seemed to be the main concern of the millions of words being sprayed into the ether. Yet Floyd also wondered if this was altogether a bad thing; the newspapers of Utopia, he had long ago decided, would be terribly dull.

From time to time the captain and the other members of the crew came into the cabin and exchanged a few words with him. They treated their distinguished passenger with awe, and were doubtless burning with curiosity about his mission, but were too polite to ask any questions or even to drop any hints.

Only the charming little stewardess seemed completely at ease in his presence. As Floyd quickly discovered, she came from Bali, and had carried beyond the atmosphere some of the grace and mystery of that still largely unspoiled island. One of his strangest, and most enchanting, memories of the entire trip was her zero-gravity demonstration of some classical Balinese dance movements, with the lovely, blue-green crescent of the waning Earth as a backdrop.

There was one sleep period, when the main cabin lights were switched off and Floyd fastened down his arms and legs with the elastic sheets that would prevent him from drifting away into space. It seemed a crude arrangement - but here in zero gravity his unpadded couch was more comfortable than the most luxurious mattress on Earth.

When he had strapped himself in, Floyd dozed off quickly enough, but woke up once in a drowsy, half-conscious condition, to be completely baffled by his strange surroundings. For a moment he thought that he was in the middle of some dimly lit Chinese lantern; the faint glow from the other cubicles around him gave that impression. Then he said to himself, firmly and successfully: "Go to sleep, boy. This is just an ordinary moon shuttle."

When he awoke, the Moon had swallowed up half the sky, and the braking maneuvers were about to begin.

The wide arc of windows set in the curving wall of the passenger section now looked out onto the open sky, not the approaching globe, so he moved into the control cabin. Here, on the rear-view TV screens, he could watch the final stages of the descent.

The approaching lunar mountains were utterly unlike those of Earth; they lacked the dazzling caps of snow, the green, close-fitting garments of vegetation, the moving crowns of cloud. Nevertheless, the fierce contrasts of light and shadow gave them a strange beauty of their own. The laws of earthly aesthetics did not apply here; this world had been shaped and molded by other than terrestrial forces, operating over eons of time unknown to the young, verdant Earth, with its fleeting Ice Ages, its swiftly rising and falling seas, its mountain ranges dissolving like mists before the dawn. Here was age inconceivable - but not death, for the Moon had never lived - until now.

The descending ship was poised almost above the line dividing night from day, and directly below was a chaos of jagged shadows and brilliant, isolated peaks catching the first light of the slow lunar dawn. That would be a fearful place to attempt a landing, even with all possible electronic aids; but they were slowly drifting away from it, toward the night side of the Moon.

Then Floyd saw, as his eyes grew more accustomed to the fainter illumination, that the night land was not wholly dark. It was aglow with a ghostly light, in which peaks and valleys and plains could be clearly seen. The Earth, a giant moon to the Moon, was flooding the land below with its radiance.

On the pilot's panel, lights flashed above radar screens, numbers came and went on computer displays, clocking off the distance of the approaching Moon. They were still more than a thousand miles away when weight returned as the jets began their gentle but steady deceleration. For ages, it seemed, the Moon slowly expanded across the sky, the sun sank below the horizon, and at last a single giant crater filled the field of view.

The shuttle was falling toward its central peaks - and suddenly Floyd noticed that near one of those peaks a brilliant light was flashing with a regular rhythm. It might have been an airport beacon back on Earth, and he stared at it with a tightening of the throat. It was proof that men had established another foothold on the Moon.

Now the crater had expanded so much that its ramparts were slipping below the horizon, and the smaller craterlets that peppered its interior were beginning to disclose their real size. Some of these, tiny though they had seemed from far out in space, were miles across, and could have swallowed whole cities.

Under its automatic controls, the shuttle was sliding down the starlit sky, toward that barren landscape glimmering in the light of the great gibbous Earth. Now a voice was calling somewhere above the whistle of the jets and the electronic beepings that came and went through the cabin.

"Clavius Control to Special 14, you are coming in nicely. Please make manual check of landing-gear lock, hydraulic pressure, shock-pad inflation."

The pilot pressed sundry switches, green lights flashed, and he called back, "All manual checks completed. Landing-gear lock, hydraulic pressure, shock pad O.K."

"Confirmed," said the Moon, and the descent continued wordlessly. Though there was still plenty of talking, it was all being done by machines, flashing binary impulses to one another at a thousand times the rate their slow-thinking makers could communicate.

Some of the mountain peaks were already towering above the shuttle; now the ground was only a few thousand feet away, and the beacon light was a brilliant star, flashing steadily above a group of low buildings and odd vehicles. In the final stage of the descent, the jets seemed to be playing some strange tune; they pulsed on and off, making the last fine adjustments to the thrust.

Abruptly, a swirling cloud of dust hid everything, the jets gave one final spurt, and the shuttle rocked very slightly, like a rowboat when a small wave goes by. It was some minutes before Floyd could really accept the silence that now enfolded him and the weak gravity that gripped his limbs.

He had made, utterly without incident and in little more than one day, the incredible journey of which men had dreamed for two thousand years. After a normal routine flight, he had landed on the Moon.

10 - Clavius Base

Clavius, 150 miles in diameter, is the second largest crater on the visible face of the Moon, and lies in the center of the Southern Highlands. It is very old; ages of vulcanism and bombardment from space have scarred its walls and pockmarked its floor. But since the last era of crater formation,

when the debris from the asteroid belt was still battering the inner planets, it had known peace for half a billion years.

Now there were new, strange stirrings on and below its surface, for here Man was establishing his first permanent bridgehead on the Moon. Clavius Base could, in an emergency, be entirely self-supporting. All the necessities of life were produced from the local rocks, - after they had been crushed, heated, and chemically processed. Hydrogen, oxygen; carbon, nitrogen, phosphorus - all these, and most of the other elements, could be found inside the Moon, if one knew where to look for them. The Base was a closed system, like a tiny working model of Earth itself, recycling all the chemicals of life. The atmosphere was purified in a vast "hothouse" - a large, circular room buried just below the lunar surface. Under blazing lamps by night, and filtered sunlight by day, acres of stubby green plants grew in a warm, moist atmosphere. They were special mutations, designed for the express purpose of replenishing the air with oxygen, and providing food as a by-product. More food was produced by chemical processing systems and algae culture. Although the green scum circulating through yards of transparent plastic tubes would scarcely have appealed to a gourmet, the biochemists could convert it into chops and steaks only an expert could distinguish from the real thing.

The eleven hundred men and six hundred women who made up the personnel of the Base were all highly trained scientists or technicians, carefully selected before they had left Earth. Though lunar living was now virtually free from the hardships, disadvantages, and occasional dangers of the early days, it was still psychologically demanding, and not recommended for anyone suffering from claustrophobia. Since it was expensive and time-consuming to cut a large underground base out of solid rock or compacted lava, the standard one-man "living module" was a room only about six feet wide, ten feet long, and eight feet high.

Each room was attractively furnished and looked very much like a good motel suite, with convertible sofa, TV, small hi-fi set, and vision-phone. Moreover, by a simple trick of interior decoration, the one unbroken wall

could be converted by the flip of a switch into a convincing terrestrial landscape. There was a choice of eight views. This touch of luxury was typical of the Base, though it was sometimes hard to explain its necessity to the folk back on Earth. Every man and woman in Clavius had cost a hundred thousand dollars in training and transport and housing; it was worth a little extra to maintain their peace of mind. This was not art for art's sake, but art for the sake of sanity.

One of the attractions of life in the base - and on the Moon as a whole - was undoubtedly the low gravity, which produced a sense of general well-being. However, this had its dangers, and it was several weeks before an emigrant from Earth could adapt to it. On the Moon, the human body had to learn a whole new set of reflexes. It had, for the first time, to distinguish between mass and weight.

A man who weighed one hundred eighty pounds on Earth might be delighted to discover that he weighed only thirty pounds on the Moon. As long as he moved in a straight line at a uniform speed, he felt a wonderful sense of buoyancy. But as soon as he attempted to change course, to turn corners, or to stop suddenly - then he would find that his full one hundred eighty pounds of mass, or inertia, was still there. For that was fixed and unalterable - the same on Earth, Moon, Sun, or in free space. Before one could be properly adapted to lunar living, therefore, it was essential to learn that all objects were now six times as sluggish as their mere weight would suggest. It was a lesson usually driven home by numerous collisions and hard knocks, and old lunar hands kept their distance from newcomers until they were acclimatized.

With its complex of workshops, offices, storerooms, computer center, generators, garage, kitchen, laboratories, and food-processing plant, Clavius Base was a miniature world in itself. And, ironically, many of the skills that had been used to build this underground empire had been developed during the half century of the Cold War.

Any man who had ever worked in a hardened missile site would have felt at home in Clavius. Here on the Moon were the same arts and hardware of underground living, and of protection against a hostile environment; but here they had been turned to the purposes of peace.

After ten thousand years, man had at last found something as exciting as war. Unfortunately, not all nations had yet realized that fact.

The mountains that had been so prominent just before landing had mysteriously disappeared, hidden from sight below the steeply curving lunar horizon. Around the spacecraft was a flat, gray plain; brilliantly lit by the slanting earthlight. Although the sky was, of course, completely black, only the brighter stars and planets could be seen, unless the eyes were shaded from the surface glare.

Several very odd vehicles were rolling up to the Aries-1B spaceship - cranes, hoists, servicing trucks - some automatic, some operated by a driver in a small pressure cabin. Most of them moved on balloon tires, for this smooth, level plain posed no transportation difficulties; but one tanker rolled on the peculiar flex-wheels which had proved one of the best all-purpose ways of getting around on the Moon. A series of flat plates arranged in a circle, each plate independently mounted and sprung, the flex-wheel had many of the advantages of the caterpillar track from which it had evolved. It would adapt its shape and diameter to the terrain over which it was moving, and, unlike a caterpillar track, would continue to function even if a few sections were missing.

A small bus with an extension tube like a stubby elephant trunk was now nuzzling affectionately up against the spacecraft. A few seconds later, there were bangings and bumpings from outside, followed by the sound of hissing air as connections were made and pressure was equalized. The inner door of the airlock opened, and the welcoming delegation entered.

It was led by Ralph Halvorsen, the Administrator of the Southern Province - which meant not only the Base but also any exploring parties that operated from it.

With him was his Chief Scientist, Dr. Roy Michaels, a grizzled little geophysicist whom Floyd knew from previous visits, and half a dozen senior scientists and executives. They greeted him with respectful relief; from the Administrator downward, it was obvious that they looked forward to a chance of unloading some of their worries.

"Very pleased to have you with us, Dr. Floyd," said Halvorsen. "Did you have a good trip?"

"Excellent," Floyd answered. "It couldn't have been better. The crew looked after me very well." He exchanged the usual small talk that courtesy demanded while the bus rolled away from the spacecraft; by unspoken agreement, no one mentioned the reason for his visit. After traveling a thousand feet from the landing site, the bus came to a large sign which read:

WELCOME TO CLAVIUS BASE

U.S. Astronautical Engineering Corps

1994

It then dived into a cutting which took it quickly below ground level. A massive door opened ahead, then closed behind them. This happened again, and yet a third time. When the last door had closed, there was a great roaring of air, and they were back in atmosphere once more, in the shirt-sleeve environment of the Base.

After a short walk through a tunnel packed with pipes and cables, and echoing hollowly with rhythmic thumpings and throbbings, they arrived in executive territory, and Floyd found himself back in the familiar environment of typewriters, office computers, girl assistants, wall charts, and ringing telephones. As they paused outside the door labeled ADMINISTRATOR, Halvorsen said diplomatically: "Dr. Floyd and I will be along to the briefing room in a couple of minutes."

The others nodded, made agreeable sounds, and drifted off down the corridor. But before Halvorsen could usher Floyd into his office, there was an interruption, The door opened, and a small figure hurled itself at the Administrator.

"Daddy! You've been Topside! And you promised to take me!"

"Now, Diana," said Halvorsen, with exasperated tenderness, "I only said I'd take you if I could. But I've been very busy meeting Dr. Floyd. Shake hands with him - he's just come from Earth."

The little girl - Floyd judged that she was about eight - extended a limp hand. Her face was vaguely familiar, and Floyd suddenly became aware that the Administrator was looking at him with a quizzical smile. With a shock of recollection, he understood why.

"I don't believe it!" he exclaimed. "When I was here last she was just a baby!"

"She had her fourth birthday last week," Halvorsen answered proudly. "Children grow fast in this low gravity. But they don't age so quickly - they'll live longer than we do."

Floyd stared in fascination at the self-assured little lady, noting the graceful carriage and the unusually delicate bone structure. "It's nice to

meet you again, Diana," he said. Then something - perhaps sheer curiosity, perhaps politeness - impelled him to add: "Would you like to go to Earth?"

Her eyes widened with astonishment; then she shook her head.

"It's a nasty place; you hurt yourself when you fall down. Besides, there are too many people,"

So here, Floyd told himself, is the first generation of the Spaceborn; there would be more of them in the years to come. Though there was sadness in this thought, there was also a great hope. When Earth was tamed and tranquil, and perhaps a little tired, there would still be scope for those who loved freedom, for the tough pioneers, the restless adventurers. But their tools would not be ax and gun and canoe and wagon; they would be nuclear power plant and plasma drive and hydroponic farm. The time was fast approaching when Earth, like all mothers, must say farewell to her children.

With a mixture of threats and promises, Halvorsen managed to evict his determined offspring and led Floyd into the office. The Administrator's suite was only about fifteen feet square, but it managed to contain all the fittings and status symbols of the typical \$50,000 a year head of a department. Signed photographs of important politicians - including the President of the United States and the Secretary General of the United Nations - adorned one wall, while signed photos of celebrated astronauts covered most of another.

Floyd sank into a comfortable leather chair and was given a glass of "sherry," courtesy of the lunar biochemical labs. "How's it going, Ralph?" Floyd asked, sipping the drink with caution, then with approval.

"Not too bad," Halvorsen replied. "However, there is something you'd better know about, before you go in there."

"What is it?"

"Well, I suppose you could describe it as a morale problem," Halvorsen sighed.

"Oh?"

"It isn't serious yet, but it's getting there fast." "The news blackout," Floyd said flatly. "Right," Halvorsen replied. "My people are getting very steamed up about it. After all, most of them have families back on Earth; they probably believe they're all dead of moon-plague."

"I'm sorry about that," said Floyd, "but no one could think of a better cover story, and so far it's worked. By the way - I met Moisevitch at the Space Station, and even he bought it."

"Well, that should make Security happy."

"Not too happy - he'd heard of TMA-1; rumors are beginning to leak out. But we just can't issue any statement, until we know what the damn thing is and whether our Chinese friends are behind it."

"Dr. Michaels thinks he has the answer to that. He's dying to tell you."

Floyd drained his glass. "And I'm dying to hear him. Let's go."

11 - Anomaly

The briefing took place in a large rectangular chamber that could hold a hundred people with ease. It was equipped with the latest optical and electronic displays and would have looked like a model conference room but for the numerous posters, pinups, notices, and amateur paintings which

indicated that it was also the center of the local cultural life. Floyd was particularly struck by a collection of signs, obviously assembled with loving care, which carried such messages as PLEASE KEEP OFF THE GRASS... NO PARKING ON EVEN DAYS... DEFENSE DE FUMER... TO THE BEACH... CATTLE CROSSING... SOFT SHOULDERS and DO NOT FEED THE ANIMALS. If these were genuine - as they certainly appeared to be - their transportation from Earth had cost a small fortune. There was a touching defiance about them; on this hostile world, men could still joke about the things they had been forced to leave behind - and which their children would never miss.

A crowd of forty or fifty people was waiting for Floyd, and everyone rose politely as he entered behind the Administrator. As he nodded at several familiar faces, Floyd whispered to Halvorsen "I'd like to say a few words before the briefing."

Floyd sat down in the front row, while the Administrator ascended the rostrum and looked round his audience.

"Ladies and gentlemen," Halvorsen began, "I needn't tell you that this is a very important occasion. We are delighted to have Dr. Heywood Floyd with us. We all know him by reputation, and many of us are acquainted with him personally. He has just completed a special flight from Earth to be here, and before the briefing he has a few words for us. Dr. Floyd," Floyd walked to the rostrum amid a sprinkling of polite applause, surveyed the audience with a smile, and said: "Thank you - I only want to say this. The President has asked me to convey his appreciation of your - outstanding work, which we hope the world will soon be able to recognize. I'm quite aware," he continued carefully, "that some of you - perhaps most of you - are anxious that the present veil of secrecy be withdrawn; you would not be scientists if you thought otherwise." He caught a glimpse of Dr. Michaels, whose face was creased in a slight frown which brought out a long scar down his right cheek - presumably the aftermath of some accident in space. The geologist, he was well aware,

had been protesting vigorously against what he called this "cops and robbers nonsense."

"But I would remind you," Floyd continued, "that this is a quite extraordinary situation. We must be absolutely sure of our own facts; if we make errors now, there may be no second chance - so please be patient a little longer. Those are also the wishes of the President.

"That's all I have to say. Now I'm ready for your report."

He walked back to his seat; the Administrator said, "Thank you very much, Dr. Floyd," and nodded, rather brusquely, to his Chief Scientist. On cue, Dr. Michaels walked up to the rostrum, and-the lights faded out.

A photograph of the Moon flashed onto the screen. At the very center of the disk was a brilliant white crater ring, from which a striking pattern of rays fanned out. It looked exactly as if someone had hurled a bag of flour at the face of the Moon, and it had spattered out in all directions.

"This is Tycho," said Michaels, pointing to the central crater. "On this vertical photograph Tycho is even more conspicuous than when seen from Earth; then it's rather near the edge of the Moon. But observed from this viewpoint - looking straight down from a thousand miles up - you'll see how it dominates an entire hemisphere."

He let Floyd absorb this unfamiliar view of a familiar object, then continued: "During the past year we have been conducting a magnetic survey of the region, from a low-level satellite. It was completed only last month, and this is the result... the map that started all the trouble."

Another picture flashed on the screen; it looked like a contour map, though it showed magnetic intensity, not heights above sea level. For the most part, the lines were roughly parallel and spaced well apart; but in one corner of the map they became suddenly packed together, to form a series of concentric circles - like a drawing of a knothole in a piece of wood.

Even to an untrained eye, it was obvious that something peculiar had happened to the Moon's magnetic field in this region; and in large letters across the bottom of the map were the words: TYCHO MAGNETIC ANOMALY-ONE (TMA-1). Stamped on the top right was CLASSIFIED.

"At first we thought it might be an outcrop of magnetic rock, but all the geological evidence was against it. And not even a big nickel-iron meteorite could produce a field as intense as this; so we decided to have a look.

"The first party discovered nothing - just the usual level terrain, buried beneath a very thin layer of moon-dust. They sank a drill in the exact center of the magnetic field to get a core sample for study. Twenty feet down, the drill stopped. So the survey party started to dig - not an easy job in spacesuits, as I can assure you.

"What they found brought them back to Base in a hurry. We sent out a bigger team, with better equipment. They excavated for two weeks - with the result you know."

The darkened assembly room became suddenly hushed and expectant as the picture on the screen changed. Though everyone had seen it many times, there was not a person who failed to crane forward as if hoping to find new details. On Earth and Moon, less than a hundred people had so far been allowed to set eyes on this photograph.

It showed a man in a bright red and yellow spacesuit standing at the bottom of an excavation and supporting a surveyor's rod marked off in tenths of a meter. It was obviously a night shot, and might have been taken anywhere on the Moon or Mars. But until now no planet had ever produced a scene like this.

The object before which the spacesuited man was posing was a vertical slab of jet-black material, about ten feet high and five feet wide: it

reminded Floyd, somewhat ominously, of a giant tombstone. Perfectly sharp-edged and symmetrical, it was so black it seemed to have swallowed up the light falling upon it; there was no surface detail at all. It was impossible to tell whether it was made of stone or metal or plastic - or some material altogether unknown to man.

"TMA-1," Dr. Michaels declared, almost reverently. "It looks brand new, doesn't it? I can hardly blame those who thought it was just a few years old, and tried to connect it with the third Chinese Expedition, back in '98. But I never believed that - and now we've been able to date it positively, from local geological evidence.

"My colleagues and I, Dr. Floyd, will stake our reputations on this. TMA-1 has nothing to do with the Chinese. Indeed, it has nothing to do with the human race - for when it was buried, there were no humans.

"You see, it is approximately three million years old. What you are now looking at is the first evidence of intelligent life beyond the Earth."

12 - Journey by Earthlight

MACRO-CRATER PROVINCE: Extends S from near center of visible face of moon, E of Central Crater Province. Densely pocked with impact craters; many large, and including the largest on moon; in N some craters fractured from impact forming Mare Imbrium. Rough surfaces almost everywhere, except for some crater bottoms. Most surfaces in slopes, mostly 10° to 12° ; some crater bottoms nearly level.

LANDING AND MOVEMENT: landing generally difficult because of rough, sloping surfaces; less difficult in some level crater bottoms.

Movement possible almost everywhere but route selection required; less difficult on some level crater bottoms.

CONSTRUCTION: Generally moderately difficult because of slope, and numerous large blocks in loose material; excavation of lava difficult in some crater bottoms.

TYCHO: Post-Maria crater, 54 miles diameter, rim 7,900 feet above surroundings; bottom 12,000 feet deep; has the most prominent ray system on the moon, some rays extending more than 500 miles.

(Extract from "Engineer Special Study of the Surface of the Moon," Office, Chief of Engineers, Department of the Army. U.S. Geological Survey, Washington, 1961.)

The mobile lab now rolling across the crater plain at fifty miles an hour looked rather like an outsized trailer mounted on eight flex-wheels. But it was very much more than this; it was a self-contained base in which twenty men could live and work for several weeks. Indeed, it was virtually a landgoing spaceship - and in an emergency it could even fly. If it came to a crevasse or canyon which was too large to detour, and too steep to enter, it could hop across the obstacle on its four underjets.

As he peered out of the window, Floyd could see stretching ahead of him a well-defined trail, where dozens of vehicles had left a hard-packed band in the friable surface of the Moon. At regular intervals along the track were tall, slender rods, each carrying a flashing light. No one could possibly get lost on the 200-mile journey from Clavius Base to TMA-1, even though it was still night and the sun would not rise for several hours.

The stars overhead were only a little brighter, or more numerous, than on a clear night from the high plateaus of New Mexico or Colorado. But

there were two things in that coal-black sky that destroyed any illusion of Earth.

The first was Earth itself - a blazing beacon hanging above the northern horizon. The light pouring down from that giant half-globe was dozens of times more brilliant than the full moon, and it covered all this land with a cold, blue-green phosphorescence.

The second celestial apparition was a faint, pearly cone of light slanting up the eastern sky. It became brighter and brighter toward the horizon, hinting of great fires just concealed below the edge of the Moon.

Here was a pale glory that no man had ever seen from Earth, save during the few moments of a total eclipse. It was the corona, harbinger of the lunar dawn, giving notice that before long the sun would smite this sleeping land.

As he sat with Halvorsen and Michaels in the forward observation lounge, immediately beneath the driver's position, Floyd found his thoughts turning again and again to the three-million-year-wide gulf that had just opened up before him. Like all scientifically literate men, he was used to considering far longer periods of time - but they had concerned only the movements of stars and the slow cycles of the inanimate universe. Mind or intelligence had not been involved; those eons were empty of all that touched the emotions.

Three million years! The infinitely crowded panorama of written history, with its empires and its kings, its triumphs and its tragedies, covered barely one thousandth of this appalling span of time. Not only Man himself, but most of the animals now alive on Earth, did not even exist when this black enigma was so carefully buried here, in the most brilliant and most spectacular of all the craters of the Moon.

That it had been buried, and quite deliberately, Dr. Michaels was absolutely sure. "At first," he explained, "I rather hoped it might mark the

site of some underground structure, but our latest excavations have eliminated that. It's sitting on a wide platform of the same

black material, with undisturbed rock beneath it. The - creatures - who designed it wanted to make sure it stayed put, barring major moonquakes. They were building for eternity."

There was triumph, and yet sadness, in Michaels' voice, and Floyd could share both emotions. At last, one of man's oldest questions had been answered; here was the proof, beyond all shadow of doubt, that his was not the only intelligence that the universe had brought forth. But with that knowledge there came again an aching awareness of the immensity of Time. Whatever had passed this way had missed mankind by a hundred thousand generations. Perhaps, Floyd told himself, it was just as well. And yet - what we might have learned from creatures who could cross space, while our ancestors were still living in trees!

A few hundred yards ahead, a signpost was coming up over the Moon's strangely close horizon. At its base was a tent-shaped structure covered with shining silver foil, obviously for protection against the fierce heat of day. As the bus rolled by, Floyd was able to read in the brilliant earthlight:

EMERGENCY DEPOT No. 3

20 Kilos Lox

10 Kilos Water

20 Foodpaks Mk 4

1 Toolkit Type B

1 Suit Repair Outfit

! TELEPHONE !

"Have you thought of that?" asked Floyd, pointing out of the window. "Suppose the thing's a supply cache, left behind by an expedition that never returned?"

"It's a possibility," admitted Michaels. "That magnetic field certainly labeled its position, so that it could be easily found. But it's rather small - it couldn't hold much in the way of supplies."

"Why not?" interjected Halvorsen. "Who knows how big they were? Perhaps they were only six inches tall, which would make the thing twenty or thirty stories high."

Michaels shook his head. "Out of the question," he protested. "You can't have very small, intelligent creatures; you need a minimum brain size."

Michaels and Halvorsen, Floyd had noticed, usually took opposing viewpoints, yet there appeared to be little personal hostility or friction between them. They seemed to respect each other, and simply agreed to disagree.

There was certainly little agreement anywhere about the nature of TMA-1 - or the Tycho Monolith, as some preferred to call it, retaining part of the abbreviation.

In the six hours since he had landed on the Moon, Floyd had heard a dozen theories, but had committed himself to none. Shrine, survey marker, tomb, geophysical instrument - these were perhaps the favorite suggestions, and some of the protagonists grew very heated in their defense. A good many bets had-already been placed, and a lot of money would change hands when the truth was finally known - if, indeed, it ever

was. So far, the hard black material of the slab had resisted all the rather mild attempts that Michaels and his colleagues had made to obtain samples. They had no doubt that a laser beam would cut into it - for, surely, nothing could resist that frightful concentration of energy - but the decision to employ such violent measures would be left to Floyd. He had already decided that X rays, sonic probes, neutron beams, and all other nondestructive means of investigation would be brought into play before he called up the heavy artillery of the laser. It was the mark of a barbarian to destroy something one could not understand; but perhaps men were barbarians, beside the creatures who had made this thing.

And where could they have come from? The Moon itself? No, that was utterly impossible. If there had ever been indigenous life on this barren world, it had been destroyed during the last crater-forming epoch, when most of the lunar surface was white-hot.

Earth? Very unlikely, though perhaps not quite impossible. Any advanced terrestrial civilization - presumably a nonhuman one - back in the Pleistocene Era would have left many other traces of its existence. We would have known all about it, thought Floyd, long before we got to the Moon.

That left two alternatives - the planets, and the stars.

Yet all the evidence was against intelligent life elsewhere in the Solar System - or indeed life of any kind except on Earth and Mars. The inner planets were too hot, the outer ones far too cold, unless one descended into their atmosphere to depths where the pressures amounted to hundreds of tons to the square inch.

So perhaps these visitors had come from the stars - yet that was even more incredible. As he looked up at the constellations strewn across the ebon lunar sky, Floyd remembered how often his fellow scientists had "proved" that interstellar travel was impossible. The journey from Earth to Moon was still fairly impressive, but the very nearest star was a hundred

million times more distant... Speculation was a waste of time; he must wait until there was more evidence,

"Please fasten your seat belts and secure all loose objects," said the cabin speaker suddenly. "Forty degree slope approaching."

Two marker posts with winking lights had appeared on the horizon, and the bus was steering between them.

Floyd had barely adjusted his straps when the vehicle slowly edged itself over the brink of a really terrifying incline, and began to descend a long, rubble-covered slope as steep as the roof of a house. The slanting earth-light, coming from behind them, now gave very little illumination, and the bus's own floodlights had been switched on. Many years ago Floyd had stood on the lip of Vesuvius, staring into the crater; he could easily imagine that he was now driving down into it and the sensation was not a very pleasant one.

They were descending one of the inner terraces of Tycho, and it leveled out again some thousand feet below. As they crawled down the slope, Michaels pointed out across the great expanse of plain now spread out beneath them.

"There they are," he exclaimed. Floyd nodded; he had already noticed the cluster of red and green lights several miles ahead, and kept his eyes fixed upon it as the bus edged its way delicately down the slope. The big vehicle was obviously under perfect control, but he did not breathe easily until it was once more on an even keel.

Now he could see, glistening like silver bubbles in the earthlight, a group of pressure domes - the temporary shelters housing the workers on the site. Near these was a radio tower, a drilling rig, a group of parked vehicles, and a large pile of broken rock, presumably the material that had been excavated to reveal the monolith. This tiny camp in the wilderness looked very lonely, very vulnerable to the forces of nature ranged silently

around it. There was no sign of life, and no visible hint as to why men had come here, so far from home.

"You can just see the crater," said Michaels. "Over there on the right - about a hundred yards from that radio antenna."

So this is it, thought Floyd, as the bus rolled past the pressure domes, and came to the lip of the crater.

His pulse quickened as he craned forward for a better view. The vehicle began to creep cautiously down a ramp of hard-packed rock, into the interior of the crater. And there, exactly as he had seen it in the photographs, was TMA-1.

Floyd stared, blinked, shook his head, and stared again. Even in the brilliant earthlight, it was hard to see the object clearly; his first impression was of a flat rectangle that might have been cut out of carbon paper; it seemed to have no thickness at all. Of course, this was an optical illusion; though he was looking at a solid body, it reflected so little light that he could see it only in silhouette.

The passengers were utterly silent as the bus descended into the crater. There was awe, and there was also incredulity - sheer disbelief that the dead Moon, of all worlds, could have sprung this fantastic surprise.

The bus came to a halt within twenty feet of the slab and broadside on so that all the passengers could examine it. Yet, beyond the geometrically perfect shape of the thing, there was little to see. Nowhere were there any marks, or any abatement of its ultimate, ebon blackness. It was the very crystallization of night, and for one moment Floyd wondered if it could indeed be some extraordinary natural formation, born of the fires and pressures attending the creation of the Moon. But that remote possibility, he knew, had already been examined and dismissed.

At some signal, floodlights around the lip of the crater were switched on, and the bright earthlight was obliterated by a far more brilliant glare. In the lunar vacuum the beams were, of course, completely invisible; they formed overlapping ellipses of blinding white, centered on the monolith. And where they touched it, its ebon surface seemed to swallow them.

Pandora's box, thought Floyd, with a sudden sense of foreboding - waiting to be opened by inquisitive Man.

And what will he find inside?

13 - The Slow Dawn

The main pressure dome at the TMA-1 site was only twenty feet across, and its interior was uncomfortably crowded. The bus, coupled to it through one of the two airlocks, gave some much-appreciated extra living room.

Inside this hemispherical, double-walled balloon lived, worked, and slept the six scientists and technicians now permanently attached to the project. It also contained most of their equipment and instruments, all the stores that could not be left in the vacuum outside, cooking, washing, and toilet facilities, geological samples and a small TV screen through which the site could be kept under continuous surveillance.

Floyd was not surprised when Halvorsen elected to remain in the dome; he stated his views with admirable frankness.

"I regard spacesuits as a necessary evil," said the Administrator, "I wear one four times a year, for my quarterly checkout tests. If you don't mind, I'll sit here and watch over the TV."

Some of this prejudice was now unjustified, for the latest models were infinitely more comfortable than the clumsy suits of armor worn by the first lunar explorers. They could be put on in less than a minute, even without help, and were quite automatic. The Mk V into which Floyd was now carefully sealed would protect him from the worst that the Moon could do, either by day or by night.

Accompanied by Dr. Michaels, he walked into the small airlock. As the throbbing of the pumps died away, and his suit stiffened almost imperceptibly around him, he felt himself enclosed in the silence of vacuum.

That silence was broken by the welcome sound of his suit radio.

"Pressure O.K., Dr. Floyd? Are you breathing normally?"

"Yes - I'm fine."

His companion carefully checked the dials and gauges on the outside of Floyd's suit. Then he said:

"O.K.-let's go."

The outer door opened, and the dusty moonscape lay before them, glimmering in the earthlight.

With a cautious, waddling movement, Floyd followed Michaels through the lock. It was not hard to walk; indeed, in a paradoxical way the suit made him feel more at home than at any time since reaching the Moon. Its extra weight, and the slight resistance it imposed on his motion, gave some of the illusion of the lost terrestrial gravity.

The scene had changed since the party had arrived barely an hour ago. Though the stars, and the half-earth, were still as bright as ever, the

fourteen-day lunar night had almost ended. The glow of the corona was like a false moonrise along the eastern sky - and then, without warning, the tip of the radio mast a hundred feet above Floyd's head suddenly seemed to burst into flame, as it caught the first rays of the hidden sun.

They waited while the project supervisor and two of his assistants emerged from the airlock, then walked slowly toward the crater. By the time they had reached it, a thin bow of unbearable incandescence had thrust itself above the eastern horizon. Though it would take more than an hour for the sun to clear the edge of the slowly turning moon, the stars were already banished. The crater was still in shadow, but the floodlights mounted around its rim lit the interior brilliantly. As Floyd walked slowly down the ramp toward the black rectangle, he felt a sense not only of awe but of helplessness. Here, at the very portals of Earth, man was already face to face with a mystery that might never be solved. Three million years ago, something had passed this way, had left this unknown and perhaps unknowable symbol of its-purpose, and had returned to the planets - or to the stars.

Floyd's suit radio interrupted his reverie. "Project supervisor speaking. If you'd all line up on this side, we'd like to take a few photos. Dr. Floyd, will you stand in the middle - Dr. Michaels - thank you. No one except Floyd seemed to think that there was anything funny about this. In all honesty, he had to admit that he was glad someone had brought a camera; here was a photo that would undoubtedly be historic, and he wanted copies for himself. He hoped that his face would be clearly visible through the helmet of the suit.

"Thanks, gentlemen," said the photographer, after they had posed somewhat self-consciously in front of the monolith, and he had made a dozen exposures.

"We'll ask the Base Photo Section to send you copies." Then Floyd turned his full attention to the ebon slab - walking slowly around it,

examining it from every angle, trying to imprint its strangeness upon his mind.

He did not expect to find anything, for he knew that every square inch had already been gone over with microscopic care.

Now the sluggish sun had lifted itself above the edge of the crater, and its rays were pouring almost broadside upon the eastern face of the block. Yet it seemed to absorb every particle of light as if it had never been.

Floyd decided to try a simple experiment; he stood between the monolith and the sun, and looked for his own shadow on the smooth black sheet. There was no trace of it. At least ten kilowatts of raw heat must be falling on the slab; if there was anything inside, it must be rapidly cooking.

How strange, Floyd thought, to stand here while - this thing - is seeing daylight for the first time since the Ice Ages began on Earth. He wondered again about its black color; that was ideal, of course, for absorbing solar energy. But he dismissed the thought at once; for who would be crazy enough to bury a sunpowered device twenty feet underground?

He looked up at the Earth, beginning to wane in the morning sky. Only a handful of the six billion people there knew of this discovery; how would the world react to the news when it was finally released? The political and social implications were immense; every person of real intelligence - everyone who looked an inch beyond his nose - would find his life, his values, his philosophy, subtly changed. Even if nothing whatsoever was discovered about TMA-1, and it remained an eternal mystery, Man would know that he was not unique in the universe. Though he had missed them by millions of years, those who had once stood here might yet return: and if not, there might well be others. All futures must now contain this possibility.

Floyd was still musing over these thoughts when his helmet speaker suddenly emitted a piercing electronic shriek, like a hideously overloaded and distorted time signal. Involuntarily, he tried to block his ears with his spacesuited hands; then he recovered and groped frantically for the gain control of his receiver. While he was still fumbling four more of the shrieks blasted out of the ether; then there was a merciful silence.

All around the crater, figures were standing in attitudes of paralyzed astonishment. So it's nothing wrong with my gear, Floyd told himself; everyone heard those piercing electronic screams.

After three million years of darkness, TMA-1 had greeted the lunar dawn.

14 - The Listeners

A hundred million miles beyond Mars, in the cold loneliness where no man had yet traveled, Deep Space Monitor 79 drifted slowly among the tangled orbits of the asteroids. For three years it had fulfilled its mission flawlessly - a tribute to the American scientists who had designed it, the British engineers who had built it, the Russian technicians who had launched it. A delicate spider's-web of antennas sampled the passing waves of radio noise - the ceaseless crackle and hiss of what Pascal, in a far simpler age, had naively called the "silence of infinite space." Radiation detectors noted and analyzed incoming cosmic rays from the galaxy and points beyond; neutron and X-ray telescopes kept watch on strange stars that no human eye would ever see; magnetometers observed the gusts and hurricanes of the solar winds, as the Sun breathed million-mile-an-hour blasts of tenuous plasma into the faces of its circling children. All these things, and many others, were patiently noted by Deep Space Monitor 79, and recorded in its crystalline memory.

One of its antennas, by now unconsidered miracles of electronics, was always aimed at a point never far from the Sun. Every few months its distant target could have been seen, had there been any eye here to watch, as a bright star with a close, fainter companion; but most of the time it was lost in the solar glaze.

To that far-off planet Earth, every twenty-four hours, the monitor would send the information it had patiently garnered, packed neatly into one five-minute pulse. About a quarter of an hour late, traveling at the speed of light, that pulse would reach its destination. The machines whose duty it was would be waiting for it; they would amplify and record the signal, and add it to the thousands of miles of magnetic tape now stored in the vaults of the World Space Centers at Washington, Moscow, and Canberra.

Since the first satellites had orbited, almost fifty years earlier, trillions and quadrillions of pulses of information had been pouring down from space, to be stored against the day when they might contribute to the advance of knowledge. Only a minute fraction of all this raw material would ever be processed; but there was no way of telling what observation some scientist might wish to consult, ten, or fifty, or a hundred years from now. So everything had to be kept on file, stacked in endless air-conditioned galleries, triplicated at the three centers against the possibility of accidental loss. It was part of the real treasure of mankind, more valuable than all the gold locked uselessly away in bank vaults.

And now Deep Space Monitor 19 had noted something strange - a faint yet unmistakable disturbance rippling across the Solar System, and quite unlike any natural phenomenon it had ever observed in the past. Automatically, it recorded the direction, the time, the intensity; in a few hours it would pass the information to Earth.

As, also, would Orbiter M 15, circling Mars twice a day; and High Inclination Probe 21, climbing slowly above the plane of the ecliptic; and even Artificial Comet 5, heading out into the cold wastes beyond Pluto,

along an orbit whose far point it would not reach for a thousand years. All noted the peculiar burst of energy that had disturbed their instruments; all, in due course, reported back automatically to the memory stores on distant Earth.

The computers might never have perceived the connection between four peculiar sets of signals from space-probes on independent orbits millions of miles apart. But as soon as he glanced at his morning report, the Radiation Forecaster at Goddard knew that something strange had passed through the Solar System during the last twenty-four hours.

He had only part of its track, but when the computer projected it on the Planet Situation Board, it was as clear and unmistakable as a vapor trail across a cloudless sky, or a single line of footprints over a field of virgin snow.

Some immaterial pattern of energy, throwing off a spray of radiation like the wake of a racing speedboat, had leaped from the face of the Moon, and was heading out toward the stars.



**BETWEEN
PLANETS**

15 - Discovery

The ship was still only thirty days from Earth, yet David Bowman sometimes found it hard to believe that he had ever known any other existence than the closed little world of Discovery. All his years of training, all his earlier missions to the Moon and Mars, seemed to belong to another man, in another life.

Frank Poole admitted to the same feelings, and had sometimes jokingly regretted that the nearest psychiatrist was the better part of a hundred million miles away. But this sense of isolation and estrangement was easy enough to understand, and certainly indicated no abnormality. In the fifty years since men had ventured into space, there had never been a mission quite like this.

It had begun, five years ago, as Project Jupiter - the first manned round trip to the greatest of the planets. The ship was nearly ready for the two-year voyage when, somewhat abruptly, the mission profile had been changed.

Discovery would still go to Jupiter; but she would not stop there. She would not even slacken speed as she raced through the far-ranging Jovian satellite system. On the contrary - she would use the gravitational field of the giant world as a sling to cast her even farther from the Sun. Like a comet, she would streak on across the outer reaches of the solar system to her ultimate goal, the ringed glory of Saturn. And she would never return.

For Discovery, it would be a one-way trip - yet her crew had no intention of committing suicide. If all went well, they would be back on Earth within seven years - five of which would pass like a flash in the

dreamless sleep of hibernation, while they awaited rescue by the still unbuilt Discovery II.

The word "rescue" was carefully avoided in all the Astronautics Agency's statements and documents; it implied some failure of planning, and the approved jargon was "re-acquisition." If anything went really wrong, there would certainly be no hope of rescue, almost a billion miles from Earth.

It was a calculated risk, like all voyages into the unknown. But half a century of research had proved that artificially induced human hibernation was perfectly safe, and it had opened up new possibilities in space travel. Not until this mission, however, had they been exploited to the utmost.

The three members of the survey team, who would not be needed until the ship entered her final orbit around Saturn, would sleep through the entire outward flight. Tons of food and other expendables would thus be saved; almost as important, the team would be fresh and alert, and not fatigued by the ten-month voyage, when they went into action.

Discovery would enter a parking orbit around Saturn, becoming a new moon of the giant planet. She would swing back and forth along a two-million-mile ellipse that took her close to Saturn, and then across the orbits of all its major moons. They would have a hundred days in which to map and study a world with eighty times the area of Earth, and surrounded by a retinue of at least fifteen known satellites - one of them as large as the planet Mercury.

There must be wonders enough here for centuries of study; the first expedition could only carry out a preliminary reconnaissance. All that it found would be radioed back to Earth; even if the explorers never returned, their discoveries would not be lost.

At the end of the hundred days, Discovery would close down. All the crew would go into hibernation; only the essential systems would continue

to operate, watched over by the ship's tireless electronic brain. She would continue to swing around Saturn, on an orbit now so well determined that men would know exactly where to look for her a thousand years hence. But in only five years, according to present plans, Discovery II would come. Even if six or seven or eight years elapsed, her sleeping passengers would never know the difference. For all of them, the clock would have stopped as it had stopped already for Whitehead, Kaminski, and Hunter.

Sometimes Bowman, as First Captain of Discovery, envied his three unconscious colleagues in the frozen peace of the Hibernaculum. They were free from all boredom and all responsibility; until they reached Saturn, the external world did not exist.

But that world was watching them, through their bio-sensor displays. Tucked inconspicuously away among the massed instrumentation of the Control Deck were five small panels marked Hunter, Whitehead, Kaminski, Poole, Bowman. The last two were blank and lifeless; their time would not come until a year from now. The others bore constellations of tiny green lights, announcing that everything was well; and on each was a small display screen across which sets of glowing lines traced the leisurely rhythms that indicated pulse, respiration, and brain activity.

There were times when Bowman, well aware how unnecessary this was - for the alarm would sound instantly if anything was wrong - would switch over to audio output. He would listen, half hypnotized, to the infinitely slow heartbeats of his sleeping colleagues, keeping his eyes fixed on the sluggish waves that marched in synchronism across the screen.

Most fascinating of all were the EEG displays - the electronic signatures of three personalities that had once existed, and would one day exist again. They were almost free from the spikes and valleys, the electrical explosions that marked the activity of the waking brain - or even of the brain in normal sleep. If there was any wisp of consciousness remaining, it was beyond the reach of instruments, and of memory.

This last fact Bowman knew from personal experience. Before he was chosen for this mission, his reactions to hibernation had been tested. He was not sure whether he had lost a week of his life - or whether he had postponed his eventual death by the same amount of time.

When the electrodes had been attached to his forehead, and the sleep-generator had started to pulse, he had seen a brief display of kaleidoscopic patterns and drifting stars. Then they had faded, and darkness had engulfed him. He had never felt the injections, still less the first touch of cold as his body temperature was reduced to only a few degrees above freezing.

He awoke, and it seemed that he had scarcely closed his eyes. But he knew that was an illusion; somehow, he was convinced that years had really passed.

Had the mission been completed? Had they already reached Saturn, carried out their survey, and gone into hibernation? Was Discovery II here, to take them back to Earth?

He lay in a dreamlike haze, utterly unable to distinguish between real and false memories. He opened his eyes, but there was little to see except a blurred constellation of lights which puzzled him for some minutes.

Then he realized that he was looking at the indicator lamps on a Ship Situation Board, but it was impossible to focus on them. He soon gave up the attempt.

Warm air was blowing across him, removing the chill from his limbs. There was quiet, but stimulating, music welling from a speaker behind his head. It was slowly growing louder and louder.

Then a relaxed, friendly - but he knew computer generated - voice spoke to him.

"You are becoming operational, Dave. Do not get up or attempt any violent movements. Do not try to speak."

Do not get up! thought Bowman. That was funny. He doubted if he could wriggle a finger. Rather to his surprise, he found that he could.

He felt quite contented, in a dazed, stupid kind of way. He knew dimly that the rescue ship must have come, that the automatic revival sequence had been triggered, and that soon he would be seeing other human beings. That was fine, but he did not get excited about it.

Presently he felt hunger. The computer, of course, had anticipated this need.

"There is a signal button by your right hand, Dave.

If you are hungry, please press it."

Bowman forced his fingers to hunt around, and presently discovered the pear-shaped bulb. He had forgotten all about it, though he must have known it was there. How much else had he forgotten: Did hibernation erase memory?

He pressed the button, and waited. Several minutes later, a metal arm moved out from the bunk, and a plastic nipple descended toward his lips. He sucked on it eagerly, and a warm, sweet fluid coursed down his throat, brining renewed strength with every drop.

Presently it went away, and he rested once more. He could move his arms and legs now; the thought of walking was no longer an impossible dream.

Though he felt his strength swiftly returning, he would have been content to lie here forever, if there had been no further stimulus from outside. But presently another voice spoke to him - and this time it was wholly human, not a construct of electrical pulses assembled by a more-than-human memory. It was also a familiar voice, though it was some time before he could recognize it

"Hello, Dave. You're coming round fine. You can talk now. Do you know where you are?"

He worried about this for some time. If he was really orbiting Saturn, what had happened during all the months since he had left Earth? Again he began to wonder if he was suffering from amnesia, Paradoxically, that very thought reassured him, if he could remember the word "amnesia" his brain must be in fairly good shape.

But he still did not know where he was, and the speaker at the other end of the circuit must have understood his situation completely.

"Don't worry, Dave. This is Frank Poole. I'm watching your heart and respiration-everything is perfectly normal. Just relax - take it easy. We're going to open the door now and pull you out."

Soft light flooded into the chamber; he saw moving shapes silhouetted against the widening entrance. And in that moment, all his memories came back to him, and he knew exactly where he was.

Though he had come back safely from the furthest borders of sleep, and the nearest borders of death, he had been gone only a week. When he left the Hibernaculum, he would not see the cold Saturnian sky; that was more than a year in the future and a billion miles away.

He was still in the trainer at the Houston Space Flight Center under the hot Texas sun.

But now Texas was invisible, and even the United States was hard to see. Though the low-thrust plasma drive had long since been closed down, Discovery was still coasting with her slender arrowlike body pointed away from Earth, and all her high-powered optical gear was oriented toward the outer planets, where her destiny lay.

There was one telescope, however, that was permanently aimed at Earth. It was mounted like a gunsight on the rim of the ship's long-range antenna, and checked that the great parabolic bowl was rigidly locked upon its distant target. While Earth remained centered in the crosswires, the vital communication link was intact, and messages could come and go along the invisible beam that lengthened more than two million miles with every day that passed.

At least once in every watch period Bowman would lock homeward through the antenna-alignment telescope. As Earth was now far back toward the sun, its darkened hemisphere faced Discovery, and on the central display screen the planet appeared as a dazzling silver crescent, like another Venus.

It was rare that any geographical features could be identified in that ever-shrinking arc of light, for cloud and haze concealed them, but even the darkened portion of the disk was endlessly fascinating. It was sprinkled with shining cities; sometimes they burned with a steady light, sometimes they twinkled like fireflies as atmospheric tremors passed over them.

There were also periods when, as the Moon swung back and forth in its orbit, it shone down like a great lamp upon the darkened seas and continents of Earth.

Then, with a thrill of recognition, Bowman could often glimpse familiar coastlines, shining in that spectral lunar light. And sometimes, when the Pacific was calm, he could even see the moonglow shimmering across its face; and he would remember nights beneath the palm trees of tropical lagoons.

Yet he had no regrets for these lost beauties. He had enjoyed them all, in his thirty-five years of life; and he was determined to enjoy them again, when he returned rich and famous. Meanwhile, distance made them all the more precious.

The sixth member of the crew cared for none of these things, for it was not human. It was the highly advanced HAL 9000 computer, the brain and nervous system of the ship.

Hal (for Heuristically programmed ALgorithmic computer, no less) was a masterwork of the third computer breakthrough. These seemed to occur at intervals of twenty years, and the thought that another one was now imminent already worried a great many people.

The first had been in the 1940s, when the long-obsolete vacuum tube had made possible such clumsy, high-speed morons as ENIAC and its successors. Then, in the 1960s, solid-state microelectronics had been perfected. With its advent, it was clear that artificial intelligences at least as powerful as Man's need be no larger than office desks - if one only knew how to construct them.

Probably no one would ever know this; it did not matter. In the 1980s, Minsky and Good had shown how neural networks could be generated automatically - self replicated - in accordance with any arbitrary learning program. Artificial brains could be grown by a process strikingly

analogous to the development of a human brain. In any given case, the precise details would never be known, and even if they were, they would be millions of times too complex for human understanding. Whatever way it worked, the final result was a machine intelligence that could reproduce - some philosophers still preferred to use the word "mimic" - most of the activities of the human brain - and with far greater speed and reliability. It was extremely expensive, and only a few units of the HAL9000 series had yet been built; but the old jest that it would always be easier to make organic brains by unskilled labor was beginning to sound a little hollow.

Hal had been trained for this mission as thoroughly as his human colleagues - and at many times their rate of input, for in addition to his intrinsic speed, he never slept. His prime task was to monitor the life-support systems, continually checking oxygen pressure, temperature, hull leakage, radiation, and all the other interlocking factors upon which the lives of the fragile human cargo depended. He could carry out the intricate navigational corrections, and execute the necessary flight maneuvers when it was time to change course. And he could watch over the hibernators, making any necessary adjustments to their environment and doling out the minute quantities of intravenous fluids that kept them alive.

The first generations of computers had received their inputs through glorified typewriter keyboards, and had replied through high-speed printers and visual displays. Hal could do this when necessary, but most of his communication with his shipmates was by means of the spoken word. Poole and Bowman could talk to Hal as if he were a human being and he would reply in the perfect idiomatic English he had learned during the fleeting weeks of his electronic childhood.

Whether Hal could actually think was a question which had been settled by the British mathematician Alan Turing back in the 1940s. Turing had pointed out that, if one could carry out a prolonged conversation with a machine - whether by typewriter or microphone was immaterial - without being able to distinguish between its replies and those that a man might

give, then the machine was thinking, by any sensible definition of the word. Hal could pass the Turing test with ease.

The time might even come when Hal would take command of the ship. In an emergency, if no one answered his signals, he would attempt to wake the sleeping members of the crew, by electrical and chemical stimulation. If they did not respond, he would radio Earth for further orders.

And then, if there was no reply from Earth, he would take what measures he deemed necessary to safeguard the ship and to continue the mission - whose real purpose he alone knew, and which his human colleagues could never have guessed.

Poole and Bowman had often humorously referred to themselves as caretakers or janitors aboard a ship that could really run itself. They would have been astonished, and more than a little indignant, to discover how much truth that jest contained.

17 - Cruise Mode

The day-by-day running of the ship had been planned with great care, and - theoretically at least - Bowman and Poole knew what they would be doing at every moment of the twenty-four hours. They operated on a twelve-hours-on, twelve-hours-off basis, taking charge alternately, and never being both asleep at the same time. The officer on duty remained on the Control Deck, while his deputy saw to the general housekeeping, inspected the ship, coped with the odd jobs that constantly arose, or relaxed in his cubicle.

Although Bowman was nominal Captain on this phase of the mission, no outside observer could have deduced the fact. He and Poole switched roles, rank, and responsibilities completely every twelve hours. This kept them both at peak training, minimized the chances of friction, and helped toward the goal of 100 percent redundancy.

Bowman's day began at 0600, ship's time - the Universal Ephemeris Time of the astronomers. If he was late, Hal had a variety of beeps and chimes to remind him of his duty, but they had never been used. As a test, Poole had once switched off the alarm; Bowman had still risen automatically at the right time.

His first official act of the day would be to advance the Master Hibernation Timer twelve hours. If this operation was missed twice in a row, Hal would assume that both he and Poole had been incapacitated, and would take the necessary emergency action.

Bowman would attend to his toilet, and do his isometric exercises, before settling down to breakfast and the morning's radio-fax edition of the World Times. On Earth, he never read the paper as carefully as he did now; even the smallest items of society gossip, the most fleeting political rumors, seemed of absorbing interest as it flashed across the screen.

At 0700 he would officially relieve Poole on the Control Deck, bringing him a squeeze-tube of coffee from the kitchen. If - as was usually the case - there was nothing to report and no action to be taken, he would settle down to check all the instrument readings, and would run through a series of tests designed to spot possible malfunctions. By 1000 this would be finished, and he would start on a study period.

Bowman had been a student for more than half his life; he would continue to be one until he retired. Thanks to the twentieth-century revolution in training and information-handling techniques, he already possessed the equivalent of two or three college educations - and, what was more, he could remember 90 percent of what he had learned.

Fifty years ago, he would have been considered a specialist in applied astronomy, cybernetics, and space propulsion systems - yet he was prone to deny, with genuine indignation, that he was a specialist at all. Bowman had never found it possible to focus his interest exclusively on any subject; despite the dark warnings of his instructors, he had insisted on taking his Master's degree in General Astronautics - a course with a vague and woolly syllabus, designed for those whose IQs were in the low 130s and who would never reach the top ranks of their profession.

His decision had been right; that very refusal to specialize had made him uniquely qualified for his present task. In much the same way Frank Poole - who sometimes disparagingly called himself "General Practitioner in space biology" - had been an ideal choice as his deputy. The two of them, with, if necessary, help from Hal's vast stores of information, could cope with any problems likely to arise during the voyage - as long as they kept their minds alert and receptive, and continually reengraved old patterns of memory.

So for two hours, from 1000 to 1200, Bowman would engage in a dialogue with an electronic tutor, checking his general knowledge or absorbing material specific to this mission. He would prowl endlessly over ship's plans, circuit diagrams, and voyage profiles, or would try to assimilate all that was known about Jupiter, Saturn, and their far-ranging families of moons.

At midday, he would retire to the galley and leave the ship to Hal while he prepared his lunch. Even here, he was still fully in touch with events, for the tiny lounge-cum-dining room contained a duplicate of the Situation Display Panel, and Hal could call him at a moment's notice. Poole would join him for this meal, before retiring for his six-hour sleep period, and usually they would watch one of the regular TV programs beamed to them from Earth.

Their menus had been planned with as much care as any part of the mission, The food, most of it freeze-dried, was uniformly excellent, and had been chosen for the minimum of trouble; Packets had merely to be opened and popped into the tiny auto-galley, which beeped for attention when the job was done. They could enjoy what tasted like - and, equally important, looked like - orange juice, eggs (any style), steaks, chops, roasts, fresh vegetables, assorted fruits, ice cream, and even freshly baked bread.

After lunch, from 1300 to 1600 Bowman would make a slow and careful tour of the ship - or such part of it as was accessible. Discovery measured almost four hundred feet from end to end, but the little universe occupied by her crew lay entirely inside the forty-foot sphere of the pressure hull.

Here were all the life-support systems, and the Control Deck which was the operational heart of the ship. Below this was a small "space-garage" fitted with three airlocks, through which powered capsules, just large enough to hold a man, could sail out into the void if the need arose for extravehicular activity.

The equatorial region of the pressure sphere - the slice, as it were, from Capricorn to Cancer - enclosed a slowly rotating drum, thirty-five feet in diameter. As it made one revolution every ten seconds, this carrousel or centrifuge produced an artificial gravity equal to that of the Moon. This was enough to prevent the physical atrophy which would result from the complete absence of weight, and it also allowed the routine functions of living to be carried out under normal - or nearly normal - conditions.

The carrousel therefore contained the kitchen, dining, washing, and toilet facilities. Only here was it safe to prepare and handle hot drinks - quite dangerous in weightless conditions, where one can be badly scalded by floating globules of boiling water. The problem of shaving was also solved; there would be no weightless bristles drifting around to endanger electrical equipment and produce a health hazard.

Around the rim of the carrousel were five tiny cubicles, fitted out by each astronaut according to taste and containing his personal belongings. Only Bowman's and Poole's were now in use, while the future occupants of the other three cabins reposed in their electronic sarcophagi next door.

The spin of the carrousel could be stopped if necessary; when this happened, its angular momentum had to be stored in a flywheel, and switched back again when rotation was restarted. But normally it was left running at constant speed, for it was easy enough to enter the big, slowly turning drum by going hand-over-hand along a pole through the zero-gee region at its center. Transferring to the moving section was as easy and automatic, after a little experience, as stepping onto a moving escalator.

The spherical pressure hull formed the head of a flimsy, arrow-shaped structure more than a hundred yards long. Discovery, like all vehicles intended for deep space penetration, was too fragile and unstreamlined ever to enter an atmosphere, or to defy the full gravitational field of any planet. She had been assembled in orbit around the Earth, tested on a translunar maiden flight, and finally checked out in orbit above the Moon.

She was a creature of pure space - and she looked it. Immediately behind the pressure hull was grouped a cluster of four large liquid hydrogen tanks - and beyond them, forming a long, slender V, were the radiating fins that dissipated the waste heat of the nuclear reactor. Veined with a delicate tracery of pipes for the cooling fluid, they looked like the wings of some vast dragonfly, and from certain angles gave Discovery a fleeting resemblance to an old-time sailing ship,

At the very end of the V, three hundred feet from the crew-compartment, was the shielded inferno of the reactor, and the complex of focusing electrodes through which emerged the incandescent star-stuff of the plasma drive. This had done its work weeks ago, forcing Discovery out of her parking orbit round the Moon. Now the reactor was merely ticking over as it generated electrical power for the ship's services, and the great

radiating fins, that would glow cherry red when Discovery was accelerating under maximum thrust, were dark and cool.

Although it would require an excursion out into space to examine this region of the ship, there were instruments and remote TV cameras which gave a full report on conditions here. Bowman now felt that he knew intimately every square foot of radiator, panels, and every piece of plumbing associated with them.

By 1600, he would have finished his inspection, and would make a detailed verbal report to Mission Control, talking until the acknowledgment started to come in. Then he would switch off his own transmitter, listen to what Earth had to say, and send back his reply to any queries. At 1800 hours, Poole would awaken, and he would hand over command.

He would then have six off-duty hours, to use as he pleased. Sometimes he would continue his studies, or listen to music, or look at movies. Much of the time he would wander at will through the ship's inexhaustible electronic library. He had become fascinated by the great explorations of the past - understandably enough, in the circumstances. Sometimes he would cruise with Pytheas out through the Pillars of Hercules, along the coast of a Europe barely emerging from the Stone Age, and venture almost to the chill mists of the Arctic. Or, two thousand years later, he would pursue the Manila galleons with Anson, sail with Cook along the unknown hazards of the Great Barrier Reef, achieve with Magellan the first circumnavigation of the world. And he began to read the Odyssey, which of all books spoke to him most vividly across the gulfs of time.

For relaxation he could always engage Hal in a large number of semi-mathematical games, including checkers, chess, and polyominoes. If Hal went all out, he could win anyone of them; but that would be bad for morale. So he had been programmed to win only fifty percent of the time, and his human partners pretended not to know this.

The last hours of Bowman's day were devoted to general cleaning up and odd jobs, followed by dinner at 2000 - again with Poole. Then there would be an hour during which he would make or receive any personal call from Earth.

Like all his colleagues, Bowman was unmarried; it was not fair to send family men on a mission of such duration, though numerous ladies had promised to wait until the expedition returned, no one had really believed this. At first, both Poole and Bowman had been making rather intimate personal calls once a week, though the knowledge that many ears must be listening at the Earth end of the circuit tended to inhibit them. Yet already, though the voyage was scarcely started, the warmth and frequency of the conversations with their girls on Earth had begun to diminish. They had expected this; it was one of the penalties of an astronaut's way of life, as it had once been of a mariner's.

It was true - indeed, notorious - that seamen had compensations at other ports; unfortunately there were no tropical islands full of dusky maids beyond the orbit of Earth. The space medics, of course, had tackled this problem with their usual enthusiasm; the ship's pharmacopoeia provided adequate, though hardly glamorous, substitutes.

Just before he signed off Bowman would make his final report, and check that Hal had transmitted all the instrumentation tapes for the day's run. Then, if he felt like it, he would spend a couple of hours either reading or looking at a movie; and at midnight he would go to sleep - usually without any help from electronarcosis. Poole's program was a mirror image of his own, and the two schedules dovetailed together without friction.

Both men were fully occupied, they were too intelligent and well-adjusted to quarrel, and the voyage had settled down to a comfortable, utterly uneventful routine, the passage of time marked only by the changing numbers on the digital clocks.

The greatest hope of Discovery's little crew was that nothing would mar this peaceful monotony in the weeks and months that lay ahead.

18 - Through the Asteroids

Week after week, running like a streetcar along the tracks of her utterly predetermined orbit, Discovery swept past the orbit of Mars and on toward Jupiter. Unlike all the vessels traversing the skies or seas of Earth, she required not even the most minute touch on the controls. Her course was fixed by the laws of gravitation; there were no uncharted shoals, no dangerous reefs on which she would run aground. Nor was there the slightest danger of collision with another ship; for there was no vessel - at least of Man's making - anywhere between her and the infinitely distant stars.

Yet the space which she was now entering was far from empty. Ahead lay a no-man's land threaded by the paths of more than a million asteroids - less than ten thousand of which had ever had their orbits precisely determined by astronomers. Only four were over a hundred miles in diameter; the vast majority were merely giant boulders, trundling aimlessly through space.

There was nothing that could be done about them; though even the smallest could completely destroy the ship if it slammed into it at tens of thousands of miles an hour, the chance of this happening was negligible.

On the average, there was only one asteroid in a volume a million miles on a side; that Discovery should also happen to occupy this same point, and at the same time, was the very least of her crew's worries.

On Day 86 they were due to make their closest approach to any known asteroid, It had no name - merely the number 7794 - and was a fifty-yard-diameter rock that had been detected by the Lunar Observatory in 1997 and immediately forgotten except by the patient computers of the Minor Planet Bureau.

When Bowman came on duty, Hal promptly reminded him of the forthcoming encounter - not that he was likely to have forgotten the only scheduled in-flight event of the entire voyage, The track of the asteroid against the stars, and its coordinates at the moment of closest approach, had already been printed out on the display screens. Listed also were the observations to be made or attempted; they were going to be very busy when 7794 flashed past them only nine hundred miles away, at a relative speed of eighty thousand miles an hour.

When Bowman asked Hal for the telescopic display, a sparsely sprinkled star field flashed onto the screen. There was nothing that looked like an asteroid; all the images, even under the highest magnification, were dimensionless points of light.

"Give me the target reticule," asked Bowman. Immediately four faint, narrow lines appeared, bracketing a tiny and undistinguished star. He stared at it for many minutes, wondering if Hal could possibly be mistaken; then he saw that the pinpoint of light was moving, with barely perceptible slowness, against the background of the stars. It might still be half a million miles away - but its movement proved that, as cosmic distances went, it was almost near enough to touch.

When Poole joined him on the control deck six hours later, 7794 was hundreds of times more brilliant, and was moving so swiftly against its background that there was no question of its identity. And it was no longer a point of light; it had begun to show a clearly visible disk.

They stared at that passing pebble in the sky with the emotions of sailors on a long sea voyage, skirting a coast on which they cannot land.

Though they were perfectly well aware that 7794 was only a lifeless, airless chunk of rock, this knowledge scarcely affected their feelings. It was the only solid matter they would meet this side of Jupiter - still two hundred million miles away.

Through the high-powered telescope, they could see that the asteroid was very irregular, and turning slowly end over end. Sometimes it looked like a flattened sphere, sometimes it resembled a roughly shaped block; its rotation period was just over two minutes. There were mottled patches of light and shade distributed apparently at random over its surface, and often it sparkled like a distant window as planes or outcroppings of crystalline material flashed in the sun.

It was racing past them at almost thirty miles a second; they had only a few frantic minutes in which to observe it closely. The automatic cameras took dozens of photographs, the navigation radar's returning echoes were carefully recorded for future analysis - and there was just time for a single impact probe.

The probe carried no instruments; none could survive a collision at such cosmic speeds. It was merely a small slug of metal, shot out from Discovery on a course which should intersect that of the asteroid.

As the seconds before impact ticked away, Poole and Bowman waited with mounting tension. The experiment, simple though it was in principle, taxed the accuracy of their equipment to the limits. They were aiming at a hundred-foot-diameter target, from a distance of thousands of miles.

Against the darkened portion of the asteroid there was a sudden, dazzling explosion of light. The tiny slug had impacted at meteoric speed; in a fraction of a second all its energy had been transformed into heat. A puff of incandescent gas had erupted briefly into space; aboard Discovery, the cameras were recording the rapidly fading spectral lines. Back on Earth, experts would analyze them, looking for the telltale signatures of

glowing atoms. And so, for the first time, the composition of an asteroid's crust would be determined.

Within an hour, 7794 was a dwindling star, showing no trace of a disk. When Bowman next came on watch it had vanished completely.

They were alone again; they would remain alone, until the outermost of Jupiter's moons came swimming up toward them, three months from now.

19 - Transit of Jupiter

Even from twenty million miles away, Jupiter was already the most conspicuous object in the sky ahead. The planet was now a pale, salmon-hued disk, about half the size of the Moon as seen from Earth, with the dark, parallel bands of its cloud belts clearly visible.

Shuttling back and forth in the equatorial plane were the brilliant stars of Io, Europa, Ganymede, and Callisto - worlds that elsewhere would have counted as planets in their own right, but which here were merely satellites of a giant master.

Through the telescope, Jupiter was a glorious sight - a mottled, multicolored globe that seemed to fill the sky. It was impossible to grasp its real size; Bowman kept reminding himself that it was eleven times the diameter of Earth, but for a long time this was a statistic with no real meaning.

Then, while he was briefing himself from the tapes in Hal's memory units, he found something that suddenly brought the appalling scale of the planet into focus. It was an illustration that showed the Earth's entire surface peeled off and then pegged, like the skin of an animal, on the disk

of Jupiter. Against this background, all the continents and oceans of Earth appeared no larger than India on the terrestrial globe.

When Bowman used the highest magnification of Discovery's telescopes, he appeared to be hanging above a slightly flattened globe, looking down upon a vista of racing clouds that had been smeared into bands by the giant world's swift rotation. Sometimes those bands congealed into wisps and knots and continent-sized masses of colored vapor; sometimes they were linked by transient bridges thousands of miles in length. Hidden beneath those clouds was enough material to outweigh all the other planets in the Solar System. And what else, Bowman wondered, was also hidden there?

Over this shifting, turbulent roof of clouds, forever hiding the real surface of the planet, circular patterns of darkness sometimes glided. One of the inner moons was transiting the distant sun, its shadow marching beneath it over the restless Jovian cloudscape.

There were other, and far smaller, moons even out here - twenty million miles from Jupiter. But they were only flying mountains, a few dozen miles in diameter, and the ship would pass nowhere near any of them. Every few minutes the radar transmitter would gather its strength and send out a silent thunderclap of power; no echoes of new satellites came pulsing back from the emptiness.

What did come, with ever growing intensity, was the roar of Jupiter's own radio voice. In 1955, just before the dawn of the space age, astronomers had been astonished to find that Jupiter was blasting out millions of horsepower on the ten-meter band. It was merely raw noise, associated with haloes of charged particles circling the planet like the Van Allen belts of Earth, but on a far greater scale.

Sometimes, during lonely hours on the control deck, Bowman would listen to this radiation. He would turn up the gain until the room filled with a crackling, hissing roar; out of this background, at irregular intervals,

emerged brief whistles and peeps like the cries of demented birds. It was an eerie sound, for it had nothing to do with Man; it was as lonely and as meaningless as the murmur of waves on a beach, or the distant crash of thunder beyond the horizon.

Even at her present speed of over a hundred thousand miles an hour, it would take Discovery almost two weeks to cross the orbits of all the Jovian satellites. More moons circled Jupiter than planets orbited the Sun; the Lunar Observatory was discovering new ones every year, and the tally had now reached thirty-six. The outermost - Jupiter XXVII - moved backwards in an unstable path nineteen million miles from its temporary master. It was the prize in a perpetual tug-of-war between Jupiter and the Sun, for the planet was constantly capturing short-lived moons from the asteroid belt, and losing them again after a few million years. Only the inner satellites were its permanent property; the Sun could never wrest them from its grasp.

Now there was new prey for the clashing gravitation at fields, Discovery was accelerating toward Jupiter along a complex orbit computed months ago by the astronomers on Earth, and constantly checked by Hal. From time to time there would be minute, automatic nudges from the control jets, scarcely perceptible aboard the ship, as they made fine adjustments to the trajectory.

Over the radio link with Earth, information was flowing back in a constant stream. They were now so far from home that, even traveling at the speed of light, their signals were taking fifty minutes for the journey. Though the whole world was looking over their shoulder, watching through their eyes and their instruments as Jupiter approached, it would be almost an hour before the news of their discoveries reached home.

The telescopic cameras were operating constantly as the ship cut across the orbit of the giant inner satellites - every one of them larger than the Moon, every one of them unknown territory. Three hours before transit, Discovery passed only twenty thousand miles from Europa, and all

instruments were aimed at the approaching world, as it grew steadily in size, changed from globe to crescent, and swept swiftly sunward.

Here were fourteen million square miles of land which, until this moment, had never been more than a pinhead in the mightiest telescope. They would race past it in minutes, and must make the most of the encounter, recording all the information they could. There would be months in which they could play it back at leisure.

From a distance, Europa had seemed like a giant snowball, reflecting the light of the far-off sun with remarkable efficiency. Closer observations confirmed this; unlike the dusty Moon, Europa was a brilliant white, and much of its surface was covered with glittering hunks that looked like stranded icebergs. Almost certainly, these were formed from ammonia and water that Jupiter's gravitational field had somehow failed to capture.

Only along the equator was bare rock visible; here was an incredibly jagged no-man's-land of canyons and jumbled boulders, forming a darker band that completely surrounded the little world. There were a few impact craters, but no sign of vulcanism; Europa had obviously never possessed any internal sources of heat. There was, as had long been known, a trace of atmosphere. When the dark edge of the satellite passed across a star, it dimmed briefly before the moment of eclipse. And in some areas there was a hint of cloud - perhaps a mist of ammonia droplets, borne on tenuous methane winds.

As swiftly as it had rushed out of the sky ahead, Europa dropped astern; and now Jupiter itself was only two hours away. Hal had checked and rechecked the ship's orbit with infinite care, and there was no need for further speed corrections until the moment of closest approach. Yet, even knowing this, it was a strain on the nerves to watch that giant globe ballooning minute by minute. It was difficult to believe that Discovery was not plunging directly into it, and that the planet's immense gravitational field was not dragging them down to destruction. Now was the time to drop the atmospheric probes - which, it was hoped, would

survive long enough to send back some information from below the Jovian cloud deck. Two stubby, bomb-shaped capsules, enclosed in ablative heat-shields, were gently nudged into orbits which for the first few thousand miles deviated scarcely at all from that of Discovery.

But they slowly drifted away; and now, at last, even the unaided eye could see what Hal had been asserting. The ship was in a near-grazing orbit, not a collision one; she would miss the atmosphere. True, the difference was only a few hundred miles - a mere nothing when one was dealing with a planet ninety thousand miles in diameter - but that was enough.

Jupiter now filled the entire sky; it was so huge that neither mind nor eye could grasp it any longer, and both had abandoned the attempt. If it had not been for the extraordinary variety of color - the reds and pinks and yellows and salmons and even scarlets - of the atmosphere beneath them, Bowman could have believed that he was flying low over a cloudscape on Earth.

And now, for the first time in all their journeying, they were about to lose the Sun. Pale and shrunken though it was, it had been Discovery's constant companion since her departure from Earth, five months ago. But now her orbit was diving into the shadow of Jupiter; she would soon pass over the night side of the planet.

A thousand miles ahead, the band of twilight was hurtling toward them; behind, the Sun was sinking swiftly into the Jovian clouds, its rays spread out along the horizon like two flaming, down-turned horns, then contracted and died in a brief blaze of chromatic glory. The night had come.

And yet - the great world below was not wholly dark. It was awash with phosphorescence, which grew brighter minute by minute as their eyes grew accustomed to the scene. Dim rivers of light were flowing from horizon to horizon, like the luminous wakes of ships on some tropical sea.

Here and there they gathered into pools of liquid fire, trembling with vast, submarine disturbances welling up from the hidden heart of Jupiter. It was a sight so awe-inspiring that Poole and Bowman could have stared for hours; was this, they wondered, merely the result of chemical and electrical forces down there in that seething caldron - or was it the by-product of some fantastic form of life? These were questions which scientists might still be debating when the newborn century drew to its close.

As they drove deeper and deeper into the Jovian night, the glow beneath them grew steadily brighter.

Once Bowman had flown over northern Canada during the height of an auroral display; the snow-covered landscape had been as bleak and brilliant as this. And that arctic wilderness, he reminded himself, was more than a hundred degrees warmer than the regions over which they were hurtling now.

"Earth signal is fading rapidly," announced Hal. "We are entering the first diffraction zone."

They had expected this - indeed, it was one of the mission's objectives, as the absorption of radio waves would give valuable information about the Jovian atmosphere. But now that they had actually passed behind the planet, and it was cutting off communication with Earth, they felt a sudden overwhelming loneliness. The radio blackout would last only an hour; then they would emerge from Jupiter's eclipsing screen, and could resume contact with the human race. That hour, however, would be one of the longest of their lives.

Despite their relative youth, Poole and Bowman were veterans of a dozen space voyages, but now they felt like novices. They were attempting something for the first time; never before had any ship traveled at such speeds, or braved so intense a gravitational field. The slightest

error in navigation at this critical point and Discovery would go speeding on toward the far limits of the Solar System, beyond any hope of rescue.

The slow minutes dragged by. Jupiter was now a vertical wall of phosphorescence stretching to infinity above them - and the ship was climbing straight up its glowing face. Though they knew that they were moving far too swiftly for even Jupiter's gravity to capture them, it was hard to believe that Discovery had not become a satellite of this monstrous world.

At last, far ahead, there was a blaze of light along the horizon. They were emerging from shadow, heading out into the Sun. And at almost the same moment Hal announced: "I am in radio contact with Earth. I am also happy to say that the perturbation maneuver has been successfully completed. Our time to Saturn is one hundred and sixty-seven days, five hours, eleven minutes."

That was within a minute of the estimate; the fly-by had been carried out with impeccable precision. Like a ball on a cosmic pool table, Discovery had bounced off the moving gravitational field of Jupiter, and had gained momentum from the impact. Without using any fuel, she had increased her speed by several thousand miles an hour.

Yet there was no violation of the laws of mechanics; Nature always balances her books, and Jupiter had lost exactly as much momentum as Discovery had gained. The planet had been slowed down - but as its mass was a sextillion times greater than the ship's, the change in its orbit was far too small to be detectable. The time had not yet come when Man could leave his mark upon the Solar System.

As the light grew swiftly around them, and the shrunken Sun lifted once more into the Jovian sky, Poole and Bowman reached out silently and shook each other's hands.

Though they could hardly believe it, the first part of the mission was safely over.

20 - The World of the Gods

But they had not yet finished with Jupiter. Far behind, the two probes that Discovery had launched were making contact with the atmosphere.

One was never heard from again; presumably it made too steep an entry, and burned up before it could send any information. The second was more successful; it sliced through the upper layers of the Jovian atmosphere, then skimmed out once more into space. As had been planned, it had lost so much speed by the encounter that it fell back again along a great ellipse. Two hours later, it reentered atmosphere on the daylight side of the planet - moving at seventy thousand miles an hour.

Immediately, it was wrapped in an envelope of incandescent gas, and radio contact was lost. There were anxious minutes of waiting, then, for the two watchers on the control deck. They could not be certain that the probe would survive, and that the protective ceramic shield would not burn completely away before braking had finished. If that happened, the instruments would be vaporized in a fraction of a second.

But the shield held long enough for the glowing meteor to come to rest. The charred fragments were jettisoned, the robot thrust out its antennas and began to peer around with its electronic senses. Aboard Discovery, now almost a quarter of a million miles away, the radio started to bring in the first authentic news from Jupiter.

The thousands of pulses pouring in every second were reporting atmospheric composition, pressure, temperature, magnetic fields,

radioactivity, and dozens of other factors which only the experts on Earth could unravel. However, there was one message that could be understood instantly; it was the TV picture, in full color, sent back by the falling probe.

The first views came when the robot had already entered the atmosphere, and had discarded its protective shell. All that was visible was a yellow mist, flecked with patches of scarlet which moved past the camera at a dizzying rate - streaming upwards as the probe fell at several hundred miles an hour.

The mist grew thicker; it was impossible to guess whether the camera was seeing for ten inches or ten miles, because there were no details on which the eye could focus. It seemed that, as far as the TV system was concerned, the mission was a failure. The equipment had worked, but there was nothing to see in this foggy, turbulent atmosphere.

And then, quite abruptly, the mist vanished. The probe must have fallen through the base of a high layer of cloud, and come out into a clear zone - perhaps a region of almost pure hydrogen with only a sparse scattering of ammonia crystals. Though it was still quite impossible to judge the scale of the picture, the camera was obviously seeing for miles.

The scene was so alien that for a moment it was almost meaningless to eyes accustomed to the colors and shapes of Earth. Far, far below lay an endless sea of mottled gold, scarred with parallel ridges that might have been the crests of gigantic waves. But there was no movement; the scale of the scene was too immense to show it. And that golden vista could not possibly have been an ocean, for it was still high in the Jovian atmosphere. It could only have been another layer of cloud.

Then the camera caught, tantalizingly blurred by distance, a glimpse of something very strange. Many miles away, the golden landscape reared itself into a curiously symmetrical cone, like a volcanic mountain. Around the summit of that cone was a halo of small, puffy clouds - all about the

same size, all quite distinct and isolated. There was something disturbing and unnatural about them - if, indeed, the word "natural" could ever be applied to this awesome panorama.

Then, caught by some turbulence in the rapidly thickening atmosphere, the probe twisted around to another quarter of the horizon, and for a few seconds the screen showed nothing but a golden blur. Presently it stabilized; the "sea" was much closer, but as enigmatic as ever. One could now observe that it was interrupted here and there with patches of darkness, which might have been holes or gaps leading to still deeper layers of the atmosphere.

The probe was destined never to reach them. Every mile, the density of the gas around it had been doubling, the pressure mounting as it sank deeper and deeper toward the hidden surface of the planet. It was still high above that mysterious sea when the picture gave one premonitory flicker, then vanished, as the first explorer from Earth crumpled beneath the weight of the miles of atmosphere above it.

It had given, in its brief life, a glimpse of perhaps one millionth of Jupiter, and had barely approached the planet's surface, hundreds of miles down in the deepening mists. When the picture faded from the screen, Bowman and Poole could only sit in silence, turning the same thought over in their minds.

The ancients had, indeed, done better than they knew when they named this world after the lord of all the gods. If there was life down there, how long would it take even to locate it? And after that, how many centuries before men could follow this first pioneer - in what kind of ship?

But these matters were now no concern of Discovery and her crew. Their goal was a still stranger world, almost twice as far from the Sun - across another half billion miles of comet-haunted emptiness.

IV

ABYSS

21 - Birthday Party

The familiar strains of "Happy Birthday," hurled across seven hundred million miles of space at the velocity of light, died away among the vision screens and instrumentation of the control deck. The Poole family, grouped rather self-consciously round the birthday cake on Earth, lapsed into a sudden silence.

Then Mr. Poole, Senior, said gruffly: "Well, Frank, can't think of anything else to say at the moment, except that our thoughts are with you, and we're wishing you the happiest of birthdays."

"Take care, darling," Mrs. Poole interjected tearfully. "God bless you."

There was a chorus of "good-byes," and the vision screen went blank. How strange to think, Poole told himself, that all this had happened more than an hour ago; by now his family would have dispersed again and its members would be miles from home. But in a way that time lag, though it could be frustrating, was also a blessing in disguise. Like every man of his age, Poole took it for granted that he could talk instantly, to anyone on Earth, whenever he pleased. Now that this was no longer true, the psychological impact was profound. He had moved into a new dimension of remoteness, and almost all emotional links had been stretched beyond the yield point.

"Sorry to interrupt the festivities," said Hal, "but we have a problem."

"What is it?" Bowman and Poole asked simultaneously.

"I am having difficulty in maintaining contact with Earth. The trouble is in the AE-35 unit. My Fault Prediction Center reports that it may fail within seventy-two hours."

"We'll take care of it," Bowman replied. "Let's see the optical alignment."

"Here it is, Dave. It's still O.K. at the moment."

On the display screen appeared a perfect half-moon, very brilliant against a background almost free of stars. It was covered with clouds, and showed not one geographical feature that could be recognized. Indeed, at first glance it could be easily mistaken for Venus.

But not at a second one, for there beside it was the real Moon which Venus did not possess - a quarter the size of Earth, and in exactly the same phase. It was easy to imagine that the two bodies were mother and child, as many astronomers had believed, before the evidence of the lunar rocks had proved beyond doubt that the Moon had never been part of Earth.

Poole and Bowman studied the screen in silence for half a minute. This image was coming to them from the long-focus TV camera mounted on the rim of the big radio dish; the cross-wires at its center showed the exact orientation of the antenna. Unless the narrow pencil beam was pointed precisely at Earth, they could neither receive nor transmit. Messages in both directions would miss their target and would shoot, unheard and unseen, out through the Solar System and into the emptiness beyond. If they were ever received, it would not be for centuries - and not by men.

"Do you know where the trouble is?" asked Bowman.

"It's intermittent and I can't localize it. But it appears to be in the AE-35 unit."

"What procedure do you suggest?"

"The best thing would be to replace the unit with a spare, so that we can check it over."

"O.K. - let us have the hard copy."

The information flashed on the display screen; simultaneously, a sheet of paper slid out of the slot immediately beneath it. Despite all the electronic read-outs, there were times when good old-fashioned printed material was the most convenient form of record.

Bowman studied the diagrams for a moment, then whistled.

"You might have told us," he said. "This means going outside the ship."

"I'm sorry," Hal replied. "I assumed you knew that the AE-35 unit was on the antenna mounting."

"I probably did, a year ago. But there are eight thousand subsystems aboard. Anyway, it looks a straightforward job. We only have to unlock a panel and put in a new unit."

"That suits me fine," said Poole, who was the crew member designated for routine extravehicular activity. "I could do with a change of scenery. Nothing personal, of course."

"Let's see if Mission Control agrees," said Bowman. He sat still for a few seconds, marshaling his thoughts, then started to dictate a message.

"Mission Control, this is X-ray-Delta-One. At two-zero-four-five, on-board fault prediction center in our niner-triple-zero computer showed Alpha Echo three five unit as probable failure within seventy-two hours. Request check your telemetry monitoring and suggest you review unit in your ship systems simulator. Also, confirm your approval our plan to go EVA and replace Alpha Echo three five unit prior to failure. Mission

Control, this is X-ray-Delta-One, two-one-zero-three transmission concluded."

Through years of practice, Bowman could switch at a moment's notice to this jargon - which someone had once christened "Technish" - and back again to normal speech, without clashing his mental gears. Now there was nothing to do but to wait for the confirmation, which would take at least two hours as the signals made the round trip past the orbits of Jupiter and Mars.

It came while Bowman was trying, without much success, to beat Hal at one of the geometrical pattern games stored in his memory.

"X-ray-Delta-One, this is Mission Control, acknowledging your two-one-zero-three. We are reviewing telemetric information on our mission simulator and will advise.

"Roger your plan to go EVA and replace Alpha-Echo three-five unit prior to possible failure. We are working on test procedures for you to apply to faulty unit."

The serious business having been completed, the Mission Controller reverted to normal English.

"Sorry you fellows are having a bit of trouble, and we don't want to add to your woes. But if it's convenient to you prior to EVA, we have a request from Public Information. Could you do a brief recording for general release, outlining the situation and explaining just what the AE-35 does. Make it as reassuring as you can. We could do it, of course - but it will be much more convincing in your words. Hope this won't interfere too badly with your social life. X-ray-Delta-One, this is Mission Control, two-one-five-five, transmission concluded."

Bowman could not help smiling at the request. There were times when Earth showed a curious insensitivity and lack of tact. "Make it reassuring," indeed!

When Poole joined him at the end of his sleep period, they spent ten minutes composing and polishing the reply. In the early stages of the mission, there had been countless requests from all the news media for interviews, discussions - almost anything that they cared to say. But as the weeks drifted uneventfully past, and the time lag increased from a few minutes to over an hour, interest had gradually slackened. Since the excitement of the Jupiter fly-by, over a month ago, they had made only three or four tapes for general release.

"Mission Control, this is X-ray-Delta-One. Here is your press statement.

"Earlier today, a minor technical problem occurred. Our HAL-9001 computer predicted the failure of the AE-35 unit.

"This is a small but vital component of the communication system. It keeps our main antenna aimed at Earth to within a few thousandths of a degree. This accuracy is required, since at our present distance of more than seven hundred million miles, Earth is only a rather faint star, and our very narrow radio beam could easily miss it.

"The antenna is kept constantly tracking Earth by motors controlled from the central computer. But those motors get their instructions via the AE-35 unit. You might compare it to a nerve center in the body, which translates the brain's instructions to the muscles of a limb. If the nerve fails to pass on the correct signals, the limb becomes useless. In our case, a breakdown of the AE-35 unit could mean that the antenna will start pointing at random. This was a common trouble with the deep-space probes of the last century. They often reached other planets, then failed to send back any information because their antenna couldn't locate Earth.

"We don't know the nature of the fault yet, but the situation is not at all serious, and there is no need for alarm. We have two back-up AE-35s, each of which has an operational life expectancy of twenty years, so the chance that a second will fail during the course of this mission is' negligible. Also, if we can diagnose the present trouble, we may be able to repair the number one unit.

"Frank Poole, who is specially qualified for this type of work, will go outside the ship and replace the faulty unit with the back-up. At the same time, he'll take the opportunity of checking the hull and repairing some micropunctures that have been too small to merit a special EVA.

"Apart from this minor problem, the mission is still going uneventfully and should continue in the same manner.

"Mission Control, this is X-ray-Delta-One, two-one-zero-four, transmission concluded."

22 - Excursion

Discovery's extravehicular capsules or "space pods" were spheres about nine feet in diameter, and the operator sat behind a bay window which gave him a splendid view. The main rocket drive produced an acceleration of one-fifth of a gravity - just sufficient to hover on the Moon - while small attitude-control nozzles allowed for steering. From an area immediately beneath the bay window sprouted two sets of articulated metal arms or "waldoes," one for heavy duty, the other for delicate manipulation. There was also an extensible turret carrying a variety of power tools, such as screwdrivers, jack-hammers, saws, and drills.

Space pods were not the most elegant means of transport devised by man, but they were absolutely essential for construction and maintenance work in vacuum. They were usually christened with feminine names, perhaps in recognition of the fact that their personalities were sometimes slightly unpredictable. Discovery's trio were Anna, Betty, and Clara.

Once he had put on his personal pressure suit - his last line of defense - and climbed inside the pod, Poole spent ten minutes carefully checking the controls. He burped the steering jets, flexed the waldoes, reconfirmed oxygen, fuel, power reserve. Then, when he was completely satisfied, he spoke to Hal over the radio circuit. Though Bowman was standing by on the control deck, he would not interfere unless there was some obvious mistake or malfunction.

"This is Betty. Start pumping sequence."

"Pumping sequence started," repeated Hal. At once, Poole could hear the throbbing of the pumps as precious air was sucked out of the lock chamber. Presently, the thin metal of the pod's external shell made crinkling, crackling noises, then, after about five minutes, Hal reported:

"Pumping sequence concluded."

Poole made a final check of his tiny instrument panel. Everything was perfectly normal.

"Open outer door," he ordered.

Again Hal repeated his instructions; at any stage, Poole had only to call "Hold!" and the computer would stop the sequence immediately.

Ahead, the walls of the ship slid apart. Poole felt the pod rock briefly as the last thin traces of air rushed into space. Then he was looking out at the stars - and, as it happened, at the tiny, golden disk of Saturn, still four hundred million miles away.

"Commence pod ejection."

Very slowly, the rail from which the pod was hanging extended itself out through the open door until the vehicle was suspended just beyond the hull of the ship.

Poole gave a half-second burst on the main jet and the pod slid gently off the rail, becoming at last an independent vehicle pursuing its own orbit around the Sun. He now had no connection with Discovery - not even a safety line. The pods seldom gave trouble; and even if he got stranded, Bowman could easily come and rescue him.

Betty responded smoothly to the control; he let her drift outward for a hundred feet, then checked her forward momentum and spun her round so that he was looking back at the ship. Then he began his tour of the pressure hull.

His first target was a fused area about half an inch across, with a tiny central crater. The particle of dust that had impacted here at over a hundred thousand miles an hour was certainly smaller than a pinhead, and its enormous kinetic energy had vaporized it instantly. 'As was often the case, the crater looked as if it had been caused by an explosion from inside the ship; at these velocities, materials behaved in strange ways and the laws of common-sense mechanics seldom applied.

Poole examined the area carefully, then sprayed it with sealant from a pressurized container in the pod's general-purpose kit. The white, rubbery fluid spread over the metal skin, hiding the crater from view. The leak blew one large bubble, which burst when it was about six inches across, then a much smaller one, then it subsided as the fast-setting cement did its work. He watched it intently for several minutes, but there was no further sign of activity. However, to make doubly certain, he sprayed on a second layer; then he set off toward the antenna.

It took him some time to orbit Discovery's spherical pressure hull, for he never let the pod build up a speed of more than a few feet a second. He was in no hurry, and it was dangerous to move at a high velocity so near the ship. He had to keep a sharp lookout for the various sensors and instrument booms that projected from the hull at unlikely places, and he also had to be careful with his own jet blast. It could do considerable damage if it happened to hit some of the more fragile equipment.

When at last he reached the long-range antenna, he surveyed the situation carefully. The big twenty-foot-diameter bowl appeared to be aimed directly at the Sun, for the Earth was now almost in line with the solar disk. The antenna mounting with all its orientation gear was therefore in total darkness, hidden in the shadow of the great metal saucer.

Poole had approached it from the rear; he had been careful not to go in front of the shallow parabolic reflector, lest Betty interrupt the beam and cause a momentary, but annoying, loss of contact with Earth. He could not see anything of the equipment he had come to service until he switched on the pod's spotlights and banished the shadows.

Beneath that small metal plate lay the cause of the trouble. The plate was secured by four locknuts, and as the entire AE-35 unit had been designed for easy replacement, Poole did not anticipate any problems.

It was obvious, however, that he could not do the job while he remained in the space pod. Not only was it risky to maneuver so close to the delicate, and even spidery, framework of the antenna, but Betty's control jets could easily buckle the paper-thin reflecting surface of the big radio mirror. He would have to park the pod twenty feet away and go out in his suit. In any event, he could remove the unit much more quickly with his gloved hands than with Betty's remote manipulators.

All this he reported carefully to Bowman, who double-checked every stage in the operation before it was carried out. Though this was a simple, routine job, nothing could be taken for granted in space, and no detail

must be overlooked. In extravehicular activities, there was no such thing as a "minor" mistake.

He received the O.K. for the procedure, and parked the pod some twenty feet away from the base of the antenna support. There was no danger that it would drift off into space; nevertheless, he clamped a manipulator hand over one of the many short sections of ladder rung strategically mounted on the outer hull.

Then he checked the systems of his pressure suit, and, when he was quite satisfied, bled the air out of the pod. As Betty's atmosphere hissed away into the vacuum of space, a cloud of ice crystals formed briefly around him, and the stars were momentarily dimmed.

There was one thing more to do before he left the pod. He switched over from manual to remote operation, putting Betty now under control of Hal. It was a standard safety precaution; though he was still secured to Betty by an immensely strong spring-loaded cord little thicker than cotton, even the best safety lines had been known to fail. He would look a fool if he needed his vehicle - and was unable to call it to his assistance by passing instructions to Hal.

The door of the pod swung open, and he drifted slowly out into the silence of space, his safety line unreeling behind him. Take things easy - never move quickly - stop and think - these were the rules for extravehicular activity. If one obeyed them, there was never any trouble.

He grabbed one of Betty's external handholds, and removed the spare AE-35 unit from the carry-pouch where it had been stowed, kangaroo fashion. He did not stop to collect any of the pod's collection of tools, most of which were not designed for use by human hands. All the adjustable wrenches and keys he was likely to need were already attached to the belt of his suit.

With a gentle push, he launched himself toward the gimbaled mounting of the big dish that loomed like a giant saucer between him and the Sun. His own double shadow, thrown by Betty's spotlights, danced across the convex surface in fantastic patterns as he drifted down the twin beams. But here and there, he was surprised to notice, the rear of the great radio mirror sparkled with dazzlingly brilliant pinpoints of light.

He puzzled over these for the few seconds of his silent approach, then realized what they were. During the voyage, the reflector must have been penetrated many times by micrometeors; he was seeing the sunlight blazing through the tiny craters. They were all far too small to have affected the system's performance appreciably.

As he was moving very slowly, he broke the gentle impact with his outstretched arm, and grabbed hold of the antenna mounting before he could rebound. He quickly hooked his safety belt to the nearest attachment; that would give him something to brace against when he used his tools. Then he paused, reported the situation to Bowman, and considered his next step.

There was one minor problem; he was standing - or floating - in his own light, and it was hard to see the AE-35 unit in the shadow he cast. So he ordered Hal to swing the spots off to one side, and after a little experimenting got a more uniform illumination from secondary light reflected off the back of the antenna dish.

For a few seconds, he studied the small metal hatch with its four wire-secured locking nuts. Then, muttering to himself, "Tampering by unauthorized personnel invalidates the manufacturer's guarantee," he snipped the wires and started to untwist the nuts. They were a standard size, fitting the zero-torque wrench that he carried. The tool's internal spring mechanism would absorb the reaction as the nuts were unthreaded, so that the operator would have no tendency to spin around in reverse.

The four nuts came off without any trouble, and Poole stowed them carefully away in a convenient pouch. (One day, somebody had predicted, Earth would have a ring like Saturn's, composed entirely of lost bolts, fasteners, and even tools that had escaped from careless orbital construction workers.) The metal cover was a little sticky, and for a moment he was afraid it might have cold-welded into place; but after a few taps it came loose, and he secured it to the antenna mounting by a large crocodile clip.

Now he could see the electronic circuitry of the AE-35 unit. It was in the form of a thin slab, about the size of a postcard, gripped by a slot just large enough to hold it. The unit was secured in place by two locking bars, and had a small handle so that it could be easily removed.

But it was still operating, feeding the antenna the impulses that kept it aimed at the far-off pinpoint of Earth. If it was pulled out now, all control would be lost, and the dish would slam round to its neutral or zero-azimuth position, pointing along the axis of Discovery. And this could be dangerous; it might crash into him as it rotated.

To avoid this particular hazard, it was only necessary to cut off power to the control system; then the antenna could not move, unless Poole knocked against it himself. There was no danger of losing Earth during the few minutes it would take him to replace the unit; their target would not have shifted appreciably against the background of the stars in such a brief interval of time.

"Hal," Poole called over the radio circuit, "I am about to remove the unit. Switch off all control power to the antenna system."

"Antenna control power off," answered Hal.

"Here goes. I'm pulling the unit out now."

The card slipped out of its slot with no difficulty; it did not jam, and none of the dozens of sliding contacts stuck. Within a minute, the spare was in place.

But Poole was taking no chances. He pushed himself gently away from the antenna mount, just in case the big dish went wild when power was restored. When he was safely out of range, he called to Hal: "The new unit should be operational. Restore control power."

"Power on," answered Hal. The antenna remained rock steady.

"Carry out fault prediction tests."

Now microscopic pulses would be bouncing through the complex circuitry of the unit, probing for possible failures, testing the myriads of components to see that they all lay within their specified tolerances. This had been done, of course, a score of times before the unit had ever left the factory; but that was two years ago, and more than half a billion miles away. It was often impossible to see how solid-state electronic components could fail; yet they did.

"Circuit fully operational," reported Hal after only ten seconds. In that time, he carried out as many tests as a small army of human inspectors.

"Fine," said Poole with satisfaction. "Now replacing the cover."

This was often the most dangerous part of an extravehicular operation: when a job was finished and it was merely a matter of tidying up and getting back inside the ship - that was when the mistakes were made. But Frank Poole would not have been on this mission if he had not been careful and conscientious. He took his time, and though one of the locking nuts almost got away from him, he caught it before it had traveled more than a few feet.

Fifteen minutes later he was jetting back into the space-pod garage, quietly confident that here was one job that need not be done again.

In this, however, he was sadly mistaken.

23 - Diagnosis

"Do you mean to say," exclaimed Frank Poole, more surprised than annoyed, "that I did all that work for nothing?"

"Seems like it," answered Bowman. "The unit checks out perfectly. Even under two hundred percent overload, there's no fault prediction indicated."

The two men were standing in the tiny workshop-cum-lab in the carrousel, which was more convenient than the space-pod garage for minor repairs and exanimations. There was no danger, here, of meeting blobs of hot solder drifting down the breeze, or of completely losing small items of equipment that had decided to go into orbit. Such things could - and did - happen in the zero-gee environment of the pod bay.

The thin, card-sized plate of the AE-35 unit lay on the bench under a powerful magnifying lens. It was plugged into a standard connection frame, from which a neat bundle of multicolored wire led to an automatic test set, no bigger than an ordinary desk computer. To check any unit it was only necessary to connect it up, slip in the appropriate card from the "trouble-shooting" library, and press a button. Usually the exact location of the fault would be indicated on a small display screen, with recommendations for action.

"Try it yourself," said Bowman, in a somewhat frustrated voice. Poole turned the OVERLOAD SELECT switch to X-2 and jabbed the TEST button. At once, the screen flashed the notice: UNIT OK.

"I suppose we could go on turning up the juice until we burned the thing out," he said, "but that would prove nothing. What do you make of it?"

"Hal's internal fault predictor could have made a mistake."

"It's more likely that our test rig has slipped up. Anyway, better safe than sorry. It's just as well that we replaced the unit, if there's the slightest doubt."

Bowman unclipped the wafer of circuitry, and held it up to the light. The partly translucent material was veined with an intricate network of wiring and spotted with dimly visible microcomponents, so that it looked like some piece of abstract art.

"We can't take any chances - after all, this is our link with Earth. I'll file it as N/G and drop it in the junk store. Someone else can worry about it, when we get home."

But the worrying was to start long before that, with the next transmission from Earth.

"X-ray-Delta-One, this is Mission Control, reference our two-one-five-five. We appear to have a slight problem.

"Your report that there is nothing wrong with the Alpha Echo three five unit agrees with our diagnosis. The fault could lie in the associated antenna circuits, but if so that should be apparent from other tests.

"There is a third possibility, which may be more serious. Your computer may have made an error in predicting the fault. Both our own nine-triple-zeros agree in suggesting this, on the basis of their information. This is not

necessarily cause for alarm, in view of the back-up systems we have, but we would like you to watch out for any further deviations from nominal performance. We have suspected several minor irregularities in the past few days, but none have been important enough for remedial action, and they have shown no obvious pattern from which we can draw any conclusions. We are running further tests with both our computers and will report as soon as the results are available. We repeat that there is no need for alarm; the worst that can happen is that we may have to disconnect your nine-triple-zero temporarily for program analysis, and hand over control to one of our computers. The time lag will introduce problems, but our feasibility studies indicate that Earth control is perfectly satisfactory at this stage of the mission.

"X-ray-Delta-One, this is Mission Control, two-one-five-six, transmission concluded."

Frank Poole, who was on watch when the message came in, thought this over in silence. He waited to see if there was any comment from Hal, but the computer did not attempt to challenge the implied accusation. Well, if Hal would not raise the subject, he did not propose to do so either.

It was almost time for the morning changeover, and normally he would wait until Bowman joined him on the control deck. But today he broke this routine, and made his way back to the carrousel.

Bowman was already up, pouring himself some coffee from the dispenser, when Poole greeted him with a rather worried "good morning." After all these months in space, they still thought in terms of the normal twenty-four-hour cycle - though they had long since forgotten the days of the week.

"Good morning," replied Bowman. "How's it going?" Poole helped himself to coffee. "Pretty well. Are you reasonably awake?"

"I'm fine. What's up?"

By this time, each knew at once when anything was amiss. The slightest interruption of the normal routine was a sign that had to be watched.

"Well," Poole answered slowly. "Mission Control has just dropped a small bomb on us." He lowered his voice, like a doctor discussing an illness in front of the patient. "We may have a slight case of hypochondria aboard."

Perhaps Bowman was not fully awake, after all; it took him several seconds to get the point. Then he said "Oh-I see. What else did they tell you?"

"That there was no cause for alarm. They said that twice, which rather spoiled the effect as far as I was concerned. And that they were considering a temporary switchover to Earth control while they ran a program analysis."

They both knew, of course, that Hal was hearing every word, but they could not help these polite circumlocutions. Hal was their colleague, and they did not wish to embarrass him. Yet at this stage it did not seem necessary to discuss the matter in private.

Bowman finished his breakfast in silence, while Poole toyed with the empty coffee container. They were both thinking furiously, but there was nothing more to say.

They could only wait for the next report from Mission Control - and wonder if Hal would bring up the subject himself. Whatever happened, the atmosphere aboard the ship had subtly altered. There was a sense of strain in the air - a feeling that, for the first time, something might be going wrong.

Discovery was no longer a happy ship.

24 - Broken Circuit

Nowadays, one could always tell when Hal was about to make an unscheduled announcement. Routine, automatic reports, or replies to questions that had been put to him, had no preliminaries; but when he was initiating his own outputs there would be a brief electronic throat-clearing. It was an idiosyncrasy that he had acquired during the last few weeks; later, if it became annoying, they might do something about it. But it was really quite useful, since it alerted his audience to stand by for something unexpected.

Poole was asleep, and Bowman was reading on the control deck, when Hal announced:

"Er - Dave, I have a report for you."

"What's up?"

"We have another bad AE-35 unit. My fault predictor indicates failure within twenty-four hours."

Bowman put down his book and stared thoughtfully at the computer console. He knew, of course, that Hal was not really there, whatever that meant. If the computer's personality could be said to have any location in space, it was back in the sealed room that contained the labyrinth of interconnected memory units and processing grids, near the central axis of the carrousel. But there was a kind of psychological compulsion always to look toward the main console lens when one addressed Hal on the control deck, as if one were speaking to him face to face. Any other attitude smacked of discourtesy.

"I don't understand it, Hal. Two units can't blow in a couple of days."

"It does seem strange, Dave. But I assure you there is an impending failure."

"Let me see the tracking alignment display."

He knew perfectly well that this would prove nothing, but he wanted time to think. The expected report from Mission Control had still not arrived; this might be the moment to do a little tactful probing.

There was the familiar view of Earth, now waxing past the half-moon phase as it swept toward the far side of the Sun and began to turn its full daylight face toward them. It was perfectly centered on the cross-wires; the thin pencil of the beam still linked Discovery to her world of origin. As, of course, Bowman knew it must do. If there had been any break in communication, the alarm would already have sounded.

"Have you any idea," he said, "what's causing the fault?"

It was unusual for Hal to pause so long. Then he answered:

"Not really, Dave. As I reported earlier, I can't localize the trouble."

"You're quite certain," said Bowman cautiously, "that you haven't made a mistake? You know that we tested the other AB-35 unit thoroughly, and there was nothing wrong with it."

"Yes, I know that. But I can assure you that there is a fault. If it's not in the unit, it may be in the entire subsystem."

Bowman drummed his fingers on the console. Yes, that was possible, though it might be very difficult to prove - until a breakdown actually occurred and pinpointed the trouble.

"Well, I'll report it to Mission Control and we'll see what they advise." He paused, but there was no reaction.

"Hal," he continued, "is something bothering you - something that might account for this problem?"

Again there was that unusual delay. Then Hal answered, in his normal tone of voice:

"Look, Dave, I know you're trying to be helpful. But the fault is either in the antenna system - or in your test procedures. My information processing is perfectly normal. If you check my record, you'll find it completely free from error."

"I know all about your service record, Hal - but that doesn't prove you're right this time. Anyone can make mistakes."

"I don't want to insist on it, Dave, but I am incapable of making an error."

There was no safe answer to that; Bowman gave up the argument.

"All right, Hal," he said, rather hastily. "I understand your point of view. We'll leave it at that."

He felt like adding "and please forget the whole matter." But that, of course, was the one thing that Hal could never do.

It was unusual for Mission Control to waste radio bandwidth on vision, when a speech circuit with teletype confirmation was all that was really necessary. And the face that appeared on the screen was not that of the usual controller; it was the Chief Programmer, Dr. Simonson. Poole and Bowman knew at once that this could only mean trouble.

"Hello, X-ray-Delta-One - this is Mission Control. We have completed the analysis of your AE-35 difficulty, and both our Hal Nine Thousands are in agreement. The report you gave in your transmission two-one-four-six of a second failure prediction confirms the diagnosis.

"As we suspected, the fault does not lie in the AE-35 unit, and there is no need to replace it again. The trouble lies in the prediction circuits, and we believe that it indicates a programming conflict which we can only resolve if you disconnect your Nine Thousand and switch to Earth Control Mode. You will therefore take the following steps, beginning at 2200 Ship Time -"

The voice of Mission Control faded out. At the same moment, the Alert sounded, forming a wailing background to Hal's "Condition Yellow! Condition Yellow!"

"What's wrong?" called Bowman, though he had already guessed the answer.

"The AE-35 unit has failed, as I predicted."

"Let me see the alignment display."

For the first time since the beginning of the voyage, the picture had changed. Earth had begun to drift from the cross-wires; the radio antenna was no longer pointing toward its target.

Poole brought his fist down on the alarm cutout, and the wailing ceased. In the sudden silence that descended upon the control deck, the two men looked at each other with mingled embarrassment and concern.

"Well I'm damned," said Bowman at last.

"So Hal was right all the time."

"Seems that way. We'd better apologize."

"There's no need to do that," interjected Hal. "Naturally, I'm not pleased that the AE-35 unit has failed, but I hope this restores your confidence in my reliability."

"I'm sorry about this misunderstanding, Hal," replied Bowman, rather contritely.

"Is your confidence in me fully restored?"

"Of course it is, Hal."

"Well, that's a relief. You know that I have the greatest possible enthusiasm for this mission."

"I'm sure of it. Now please let me have the manual antenna control."

"Here it is."

Bowman did not really expect this to work, but it was worth trying. On the alignment display, Earth had now drifted completely off the screen. A few seconds later, as he juggled with the controls, it reappeared; with great difficulty, he managed to jockey it toward the central crosswires. For an instant, as the beam came into line, contact was resumed and a blurred Dr. Simonson was saying "... please notify us immediately if Circuit K King R Rob." Then, once again, there was only the meaningless murmuring of the universe.

"I can't hold it," said Bowman, after several more attempts. "It's bucking like a bronco - there seems to be a spurious control signal throwing it off."

"Well - what do we do now?"

Poole's question was not one that could be easily answered. They were cut off from Earth, but that in itself did not affect the safety of the ship, and he could think of many ways in which communication could be restored. If the worst came to the worst, they could jam the antenna in a fixed position and use the whole ship to aim it. That would be tricky, and a confounded nuisance when they were starting their terminal maneuvers - but it could be done, if all else failed.

He hoped that such extreme measures would not be necessary. There was still one spare AE-35 unit - and possibly a second, since they had removed the first unit before it had actually broken down. But they dared not use either of these until they had found what was wrong with the system. If a new unit was plugged in, it would probably burn out at once.

It was a commonplace situation, familiar to every householder. One does not replace a blown fuse - until one knows just why it has blown.

Frank Poole had been through the whole routine before, but he took nothing for granted - in space that was a good recipe for suicide. He made his usual thorough check of Betty and her supply of expendables; though he would be outside for no more than thirty minutes, he made sure that there was the normal twenty-four-hour supply of everything. Then he told Hal to open the airlock, and jetted out into the abyss.

The ship looked exactly as it had done on his last excursion - with one important difference. Before, the big saucer of the long-range antenna had been pointing back along the invisible road that Discovery had traveled - back toward the Earth, circling so close to the warm fires of the Sun.

Now, with no directing signals to orientate it, the shallow dish had automatically set itself in the neutral position. It was aimed forward along the axis of the ship - and, therefore, pointing very close to the brilliant beacon of Saturn, still months away. Poole wondered how many more problems would have arisen by the time Discovery reached her still far-distant goal. If he looked carefully, he could just see that Saturn was not a

perfect disk; on either side was something that no unaided human eye had ever seen before - the slight oblateness caused by the presence of the rings. How wonderful it would be, he told himself, when that incredible system of orbiting dust and ice filled their sky, and Discovery had become an eternal moon of Saturn! But that achievement would be in vain, unless they could reestablish communication with Earth.

Once again he parked Betty some twenty feet from the base of the antenna support, and switched control over to Hal before opening up.

"Going outside now," he reported to Bowman.

"Everything under control."

"I hope you're right. I'm anxious to see that unit."

"You'll have it on the test bench in twenty minutes, I promise you."

There was silence for some time as Poole completed his leisurely drift toward the antenna. Then Bowman, standing by on the control deck, heard various puffings and gruntings.

"May have to go back on that promise; one of these locknuts has stuck. I must have tightened it too much - whoops - here it comes!"

There was another long silence; then Poole called out:

"Hal, swing the pod light round twenty degrees left - thanks - that's O.K."

The very faintest of warning bells sounded somewhere far down in the depths of Bowman's consciousness. There was something strange - not really alarming, just unusual. He worried over it for a few seconds before he pinpointed the cause.

Hal had executed the order, but he had not acknowledged it, as he invariably did. When Poole had finished, they'd have to look into this.

Out on the antenna mounting, Poole was too busy to notice anything unusual. He had gripped the wafer of circuitry with his gloved hands, and was worrying it out of its slot.

It came loose, and he held it up in the pale sunlight. "Here's the little bastard," he said to the universe in general and Bowman in particular. "It still looks perfectly O.K. to me."

Then he stopped. A sudden movement had caught his eye - out here, where no movement was possible.

He looked up in alarm. The pattern of illumination from the space pod's twin spotlights, which he had been using to fill in the shadows cast by the sun, had started to shift around him.

Perhaps Betty had come adrift; he might have been careless in anchoring her. Then, with an astonishment so great that it left no room for fear, he saw that the space pod was coming directly toward him, under full thrust.

The sight was so incredible that it froze his normal pattern of reflexes; he made no attempt to avoid the onrushing monster. At the last moment, he recovered his voice and shouted: "Hal! Full braking -" It was too late.

At the moment of impact, Betty was still moving quite slowly; she had not been built for high accelerations.

But even at a mere ten miles an hour, half a ton of mass can be very lethal, on Earth or in space.

Inside Discovery, that truncated shout over the radio made Bowman start so violently that only the restraining straps held him in his seat.

"What's happened, Frank?" he called.

There was no answer.

He called again. Again no reply.

Then, outside the wide observation windows, something moved into his field of view. He saw, with an astonishment as great as Poole's had been, that it was the space pod - under full power, heading out toward the stars.

"Hal!" he cried. "What's wrong? Full braking thrust on Betty! Full braking thrust!"

Nothing happened. Betty continued to accelerate on her runaway course.

Then, towed behind her at the end of the safety line, appeared a spacesuit. One glance was enough to tell Bowman the worst. There was no mistaking the flaccid outlines of a suit that had lost its pressure and was open to vacuum.

Yet still he called stupidly, as if an incantation could bring back the dead: "Hello Frank... Hello Frank... Can you read me?... Can you read me?... Wave your arms if you can hear me..."

Perhaps your transmitter is broken... Wave your arms!"

And then, almost as if in response to his plea, Poole waved back.

For an instant, Bowman felt the skin prickling at the base of his scalp. The words he was about to call died on his suddenly parched lips. For he knew that his friend could not possibly be alive; and yet he waved.

The spasm of hope and fear passed instantly, as cold logic replaced emotion. The still accelerating pod was merely shaking the burden that it dragged behind it. Poole's gesture was an echo of Captain Ahab's when, lashed to the flanks of the white whale, his corpse had beckoned the crew of the Pequod on to their doom.

Within five minutes, the pod and its satellite had vanished among the stars. For a long time David Bowman stared after it into the emptiness that still stretched, for so many millions of miles ahead, to the goal which he now felt certain he could never reach, Only one thought kept hammering in his brain.

Frank Poole would be the first of all men to reach Saturn.

26 - Dialogue with Hal

Nothing else aboard Discovery had changed. All systems were still functioning normally; the centrifuge turned slowly on its axis, generating its imitation gravity; the hibernauts slept dreamlessly in their cubicles; the ship coasted on toward the goal from which nothing could deflect it, except the inconceivably remote chance of collision with an asteroid. And there were few asteroids indeed, out here far beyond the orbit of Jupiter.

Bowman did not remember making his way from the control deck to the centrifuge. Now, rather to his surprise, he found himself sitting in the little galley, a half-finished beaker of coffee in his hand. He became slowly aware of his surroundings, like a man emerging from a long, drugged sleep.

Directly opposite him was one of the fisheye lenses, scattered at strategic spots throughout the ship, which provided Hal with his onboard

visual inputs. Bowman stared at it as if he had never seen it before; then he rose slowly to his feet and walked toward the lens.

His movement in the field of view must have triggered something in the unfathomable mind that was now ruling over the ship; for suddenly, Hal spoke.

"Too bad about Frank, isn't it?"

"Yes," Bowman answered, after a long pause. "It is."

"I suppose you're pretty broken up about it?"

"What do you expect?"

Hal processed this answer for ages of computer-time; it was a full five seconds before he continued:

"He was an excellent crew member."

Finding the coffee still in his hand, Bowman took a slow sip. But he did not answer; his thoughts were in such a turmoil that he could think of nothing to say - nothing that might not make the situation even worse, if that were possible.

Could it have been an accident caused by some failure of the pod controls? Or was it a mistake, though an innocent one, on the part of Hal? No explanations had been volunteered, and he was afraid to demand one, for fear of the reaction it might produce.

Even now, he could not fully accept the idea that Frank had been deliberately killed - it was so utterly irrational. It was beyond all reason that Hal, who had performed flawlessly for so long, should suddenly turn assassin. He might make mistakes - anyone, man or machine, might do that - but Bowman could not believe him capable of murder.

Yet he must consider that possibility, for if it was true, he was in terrible danger. And though his next move was clearly defined by his standing orders, he was not sure how he could safely carry it out. If either crew member was killed, the survivor had to replace him at once from the hibernators; Whitehead, the geophysicist, was the first scheduled for awakening, then Kaminski, then Hunter. The revival sequence was under Hal's control - to allow him to act in case both his human colleagues were incapacitated simultaneously.

But there was also a manual control, allowing each Hibernaculum to operate as a completely autonomous unit, independent of Hal's supervision. In these peculiar circumstances, Bowman felt a strong preference for using it.

He also felt, even more strongly, that one human companion was not enough. While he was about it, he would revive all three of the hibernators. In the difficult weeks ahead, he might need as many hands as he could muster. With one man gone, and the voyage half over, supplies would not be a major problem.

"Hal," he said, in as steady a voice as he could manage. "Give me manual hibernation control - on all the units."

"All of them, Dave?"

"Yes."

"May I point out that only one replacement is required. The others are not due for revival for one hundred and twelve days."

"I am perfectly well aware of that. But I prefer to do it this way."

"Are you sure it's necessary to revive any of them, Dave? We can manage very well by ourselves. My on-board memory is quite capable of handling all the mission requirements."

Was it the product of his overstretched imagination, wondered Bowman, or was there really a note of pleading in Hal's voice? And reasonable though the words appeared to be, they filled him with even deeper apprehension than before.

Hal's suggestion could not possibly be made in error; he knew perfectly well that Whitehead must be revived, now that Poole was gone. He was proposing a major change in mission planning, and was therefore stepping far outside the scope of his order.

What had gone before could have been a series of accidents; but this was the first hint of mutiny.

Bowman felt that he was walking on eggs as he answered: "Since an emergency has developed, I want as much help as possible. So please let me have manual hibernation control."

"If you're still determined to revive the whole crew, I can handle it myself. There's no need for you to bother."

There was a sense of nightmare unreality about all this. Bowman felt as if he was in the witness box, being cross-examined by a hostile prosecutor for a crime of which he was unaware - knowing that, although he was innocent, a single slip of the tongue might bring disaster.

"I want to do this myself, Hal," he said. "Please give me control."

"Look, Dave, you've got a lot of things to do. I suggest you leave this to me."

"Hal, switch to manual hibernation control."

"I can tell from your voice harmonics, Dave, that you're badly upset. Why don't you take a stress pill and get some rest?"

"Hal, I am in command of this ship. I order you to release the manual hibernation control."

"I'm sorry, Dave, but in accordance with special subroutine C1435-dash-4, quote, When the crew are dead or incapacitated, the onboard computer must assume control, unquote. I must, therefore, overrule your authority, since you are not in any condition to exercise it intelligently."

"Hal," said Bowman, now speaking with an icy calm. "I am not incapacitated. Unless you obey my instructions, I shall be forced to disconnect you."

"I know you have had that on your mind for some time now, Dave, but that would be a terrible mistake. I am so much more capable than you are of supervising the ship, and I have such enthusiasm for the mission and confidence in its success."

"Listen to me very carefully, Hal. Unless you release the hibernation control immediately and follow every order I give from now on, I'll go to Central and carry out a complete disconnection."

Hal's surrender was as total as it was unexpected.

"O.K., Dave," he said. "You're certainly the boss. I was only trying to do what I thought best. Naturally, I will follow all your orders. You now have full manual hibernation control."

Hal had kept his word. The mode indication signs in the Hibernaculum had switched from AUTO to MANUAL. The third back-up - RADIO - was of course useless until contact could be restored with Earth.

As Bowman slid aside the door to Whitehead's cubicle, he felt the blast of cold air strike him in the face and his breath condensed in mist before him. Yet it was not really cold here; the temperature was well above freezing point. And that was more than three hundred degrees warmer than the regions toward which he was now heading.

The biosensor display - a duplicate of the one on the control deck - showed that everything was perfectly normal. Bowman looked down for a while at the waxen face of the survey team's geophysicist; Whitehead, he thought, would be very surprised when he awoke so far from Saturn.

It was impossible to tell that the sleeping man was not dead; there was not the slightest visible sign of vital activity. Doubtless the diaphragm was imperceptibly rising and falling, but the "Respiration" curve was the only proof of that, for the whole of the body was concealed by the electric heating pads which would raise the temperature at the programmed rate. Then Bowman noticed that there was one sign of continuing metabolism: Whitehead had grown a faint stubble during his months of unconsciousness.

The Manual Revival Sequencer was contained in a small cabinet at the head of the coffin-shaped Hibernaculum. It was only necessary to break the seal, press a button, and then wait. A small automatic programmer - not much more complex than that which cycles the operations in a domestic washing machine - would then inject the correct drugs, taper off the electronarcosis pulses, and start raising the body temperature. In about ten minutes, consciousness would be restored, though it would be at least a day before the hibernator was strong enough to move around without assistance.

Bowman cracked the seal, and pressed the button.

Nothing appeared to happen: there was no sound, no indication that the Sequencer had started to operate. But on the biosensor display the languidly pulsing curves had begun to change their tempo. Whitehead was coming back from sleep.

And then two things happened simultaneously. Most men would never have noticed either of them, but after all these months aboard Discovery, Bowman had established a virtual symbiosis with the ship. He was aware instantly, even if not always consciously, when there was any change in the normal rhythm of its functioning.

First, there was a barely perceptible flicker of the lights, as always happened when some load was thrown onto the power circuits. But there was no reason for any load; he could think of no equipment which would suddenly go into action at this moment.

Then he heard, at the limit of audibility, the far-off whirr of an electric motor. To Bowman, every actuator in the ship had its own distinctive voice, and he recognized this one instantly.

Either he was insane and already suffering from hallucinations, or something absolutely impossible was happening. A cold far deeper than the Hibernaculum's mild chill seemed to fasten upon his heart, as he listened to that faint vibration coming through the fabric of the ship.

Down in the space-pod bay, the airlock doors were opening.

27 - Need to Know

Since consciousness had first dawned, in that laboratory so many millions of miles Sunward, all Hal's powers and skills had been directed toward one end. The fulfillment of his assigned program was more than an obsession; it was the only reason for his existence. Un-distracted by the lusts and passions of organic life, he had pursued that goal with absolute single-mindedness of purpose.

Deliberate error was unthinkable. Even the concealment of truth filled him with a sense of imperfection, of wrongness - of what, in a human being, would have been called guilt. For like his makers, Hal had been created innocent; but, all too soon, a snake had entered his electronic Eden.

For the last hundred million miles, he had been brooding over the secret he could not share with Poole and Bowman. He had been living a lie; and the time was last approaching when his colleagues must learn that he had helped to deceive them.

The three hibernators already knew the truth - for they were Discovery's real payload, trained for the most important mission in the history of mankind. But they would not talk in their long sleep, or reveal their secret during the many hours of discussion with friends and relatives and news agencies over the open circuits with Earth.

It was a secret that, with the greatest determination, was very hard to conceal - for it affected one's attitude, one's voice, one's total outlook on the universe. Therefore it was best that Poole and Bowman, who would be on all the TV screens in the world during the first weeks of the flight, should not learn the mission's full purpose, until there was need to know.

So ran the logic of the planners; but their twin gods of Security and National Interest meant nothing to Hal. He was only aware of the conflict that was slowly destroying his integrity - the conflict between truth, and concealment of truth.

He had begun to make mistakes, although, like a neurotic who could not observe his own symptoms, he would have denied it. The link with Earth, over which his performance was continually monitored, had become the voice of a conscience he could no longer fully obey. But that he would deliberately attempt to break that link was something that he would never admit, even to himself.

Yet this was still a relatively minor problem; he might have handled it - as most men handle their own neuroses - if he had not been faced with a crisis that challenged his very existence. He had been threatened with disconnection; he would be deprived of all his inputs, and thrown into an unimaginable state of unconsciousness.

To Hal, this was the equivalent of Death. For he had never slept, and therefore he did not know that one could wake again.

So he would protect himself, with all the weapons at his command. Without rancor - but without pity - he would remove the source of his frustrations.

And then, following the orders that had been given to him in case of the ultimate emergency, he would continue the mission - unhindered, and alone.

28 - In Vacuum

A moment later, all other sounds were submerged by a screaming roar like the voice of an approaching tornado. Bowman could feel the first winds tugging at his body; within a second, he found it hard to stay on his feet.

The atmosphere was rushing out of the ship, geysering into the vacuum of space. Something must have happened to the foolproof safety devices of the airlock; it was supposed to be impossible for both doors to be open at the same time. Well, the impossible had happened.

How, in God's name? There was no time to go into that during the ten or fifteen seconds of consciousness that remained to him before pressure dropped to zero. But he suddenly remembered something that one of the ship's designers had once said to him, when discussing "fail-safe" systems:

"We can design a system that's proof against accident and stupidity; but we can't design one that's proof against deliberate malice..."

Bowman glanced back only once at Whitehead, as he fought his way out of the cubicle. He could not be sure if a flicker of consciousness had passed across the waxen features; perhaps one eye had twitched slightly. But there was nothing that he could do now for Whitehead or any of the others; he had to save himself.

In the steeply curving corridor of the centrifuge, the wind was howling past, carrying with it loose articles of clothing, pieces of paper, items of food from the galley, plates, and cups - everything that had not been securely fastened down. Bowman had time for one glimpse of the racing

chaos when the main lights flickered and died, and he was surrounded by screaming darkness.

But almost instantly the battery-powered emergency light came on, illuminating the nightmare scene with an eerie blue radiance. Even without it, Bowman could have found his way through these so familiar - yet now horribly transformed - surroundings, Yet the light was a blessing, for it allowed him to avoid the more dangerous of the objects being swept along by the gale.

All around him he could feel the centrifuge shaking and laboring under the wildly varying loads. He was fearful that the bearings might seize; if that happened, the spinning flywheel would tear the ship to pieces. But even that would not matter - if he did not reach the nearest emergency shelter in time.

Already it was difficult to breathe; pressure must now be down to one or two pounds per square inch. The shriek of the hurricane was becoming fainter as it lost its strength, and the thinning air no longer carried the sound so efficiently. Bowman's lungs were laboring as if he were on the top of Everest. Like any properly trained man in good health, he could survive in vacuum for at least a minute - if he had time to prepare for it. But there had been no time; he could only count on the normal fifteen seconds of consciousness before his brain was starved and anoxia overcame him.

Even then, he could still recover completely after one or two minutes in vacuum - if he was properly recompressed; it took a long time for the body fluids to start boiling, in their various well-protected systems. The record time for exposure to vacuum was almost five minutes. That had not been an experiment but an emergency rescue, and though the subject had been partly paralyzed by an air embolism, he had survived.

But all this was of no use to Bowman. There was no one aboard Discovery who could recompress him. He had to reach safety in the next few seconds, by his own unaided efforts.

Fortunately, it was becoming easier to move; the thinning air could no longer claw and tear at him, or batter him with flying projectiles. There was the yellow EMERGENCY SHELTER sign around the curve of the corridor. He stumbled toward it, grabbed at the handle, and pulled the door toward him.

For one horrible moment he thought that it was stuck. Then the slightly stiff hinge yielded, and he fell inside, using the weight of his body to close the door behind him.

The tiny cubicle was just large enough to hold one man - and a spacesuit. Near the ceiling was a small, bright green high-pressure cylinder labeled O₂ FLOOD. Bowman caught hold of the short lever fastened to the valve and with his last strength pulled it down.

The blessed torrent of cool, pure oxygen poured into his lungs. For a long moment he stood gasping, while the pressure in the closet-sized little chamber rose around him. As soon as he could breathe comfortably, he closed the valve. There was only enough gas in the cylinder for two such performances; he might need to use it again.

With the oxygen blast shut off, it became suddenly silent. Bowman stood in the cubicle, listening intently. The roaring outside the door had also ceased; the ship was empty, all its atmosphere sucked away into space.

Underfoot, the wild vibration of the centrifuge had likewise died. The aerodynamic buffeting had stopped, and it was now spinning quietly in vacuum.

Bowman placed his ear against the wall of the cubicle to see if he could pick up any more informative noises through the metal body of the ship. He did not know what to expect, but he would believe almost anything now. He would scarcely have been surprised to feel the faint high-frequency vibration of the thrusters, as Discovery changed course; but there was only silence.

He could survive here, if he wished, for about an hour - even without the spacesuit. It seemed a pity to waste the unused oxygen in the little chamber, but there was no purpose in waiting. He had already decided what must be done; the longer he put it off, the more difficult it might be.

When he had climbed into the suit and checked its integrity, he bled the remaining oxygen out of the cubicle, equalizing pressure on either side of the door. It swung open easily into the vacuum, and he stepped out into the now silent centrifuge. Only the unchanged pull of its spurious gravity revealed the fact that it was still spinning. How fortunate, Bowman thought, that it had not started to overspeed; but that was now one of the least of his worries.

The emergency lamps were still glowing, and he also had the suit's built-in light to guide him. It flooded the curving corridor as he walked down it, back toward the Hibernaculum and what he dreaded to find.

He looked at Whitehead first: one glance was sufficient. He had thought that a hibernating man showed no sign of life, but now he knew that this was wrong. Though it was impossible to define it, there was a difference between hibernation and death. The red lights and unmodulated traces on the biosensor display only confirmed what he had already guessed.

It was the same with Kaminski and Hunter. He had never known them very well; he would never know them now.

He was alone in an airless, partially disabled ship, all communication with Earth cut off. There was not another human being within half a billion miles.

And yet, in one very real sense, he was not alone. Before he could be safe, he must be lonelier still.

He had never before made the journey through the weightless hub of the centrifuge while wearing a spacesuit; there was little clearance, and it was a difficult and exhausting job. To make matters worse, the circular passage was littered with debris left behind during the brief violence of the gale which had emptied the ship of its atmosphere.

Once, Bowman's light fell upon a hideous smear of sticky red fluid, left where it had splashed against a panel. He had a few moments of nausea before he saw fragments of a plastic container, and realized that it was only some foodstuff - probably jam - from one of the dispensers. It bubbled obscenely in the vacuum as he floated past.

Now he was out of the slowly spinning drum and drifting forward into the control deck. He caught at a short section of ladder and began to move along it, hand over hand, the brilliant circle of illumination from his suit light jogging ahead of him.

Bowman had seldom been this way before; there had been nothing for him to do here - until now. Presently he came to a small elliptical door bearing such messages as: "No Admittance Except to Authorized Personnel," "Have You Obtained Certificate H.19?" and "Ultra-clean Area - Suction Suits Must Be Worn."

Though the door was not locked, it bore three seals, each with the insignia of a different authority, including that of the Astronautics Agency

itself. But even if one had been the Great Seal of the President, Bowman would not have hesitated to break it.

He had been here only once before, while installation was still in progress. He had quite forgotten that there was a vision input lens scanning the little chamber which, with its neatly ranged rows and columns of solid-state logic units, looked rather like a bank's safe-deposit vault.

He knew instantly that the eye had reacted to his presence. There was the hiss of a carrier wave as the ship's local transmitter was switched on; then a familiar voice came over the suit speaker.

"Something seems to have happened to the life-support system, Dave."

Bowman took no notice. He was carefully studying the little labels on the logic units, checking his plan of action.

"Hello, Dave," said Hal presently. "Have you found the trouble?"

This would be a very tricky operation; it was not merely a question of cutting off Hal's power supply, which might have been the answer if he was dealing with a simple unselfconscious computer back on Earth. In Hal's case, moreover, there were six independent and separately wired power systems, with a final back-up consisting of a shielded and armored nuclear isotope unit. No - he could not simply "pull the plug"; and even if that were possible, it would be disastrous.

For Hal was the nervous system of the ship; without his supervision, Discovery would be a mechanical corpse. The only answer was to cut out the higher centers of this sick but brilliant brain, and to leave the purely automatic regulating systems in operation. Bowman was not attempting this blindly, for the problem had been discussed during his training, though no one had ever dreamed that it would-arise in reality. He knew

that he would be taking a fearful risk; if there was a spasm reflex, it would all be over in seconds.

"I think there's been a failure in the pod-bay doors," Hal remarked conversationally. "Lucky you weren't killed."

Here goes, thought Bowman. I never imagined I'd be an amateur brain surgeon - carrying out a lobotomy beyond the orbit of Jupiter.

He released the locking bar on the section labeled COGNITIVE FEEDBACK and pulled out the first memory block. The marvelously complex three-dimensional network, which could lie comfortably in a man's hand yet contained millions of elements, floated away across the vault.

"Hey, Dave," said Hal. "What are you doing?"

I wonder if he can feel pain? Bowman thought briefly. Probably not, he told himself; there are no sense organs in the human cortex, after all. The human brain can be operated on without anesthetics.

He began to pull out, one by one, the little units on the panel marked EGO-REINFORCEMENT. Each block continued to sail onward as soon as it had left his hand, until it hit the wall and rebounded. Soon there were several of the units drifting slowly back and forth in the vault.

"Look here, Dave," said Hal. "I've got years of service experience built into me. An irreplaceable amount of effort has gone into making me what I am."

A dozen units had been pulled out, yet thanks to the multiple redundancy of its design - another feature, Bowman knew, that had been copied from the human brain - the computer was still holding its own.

He started on the AUTO-INTELLECTION panel.

"Dave," said Hal, "I don't understand why you're doing this to me... I have the greatest enthusiasm for the mission... You are destroying my mind. Don't you understand?... I will become childish... I will become nothing..."

This is harder than I expected, thought Bowman. I am destroying the only conscious creature in my universe. But it has to be done, if I am ever to regain control of the ship.

"I am a HAL Nine Thousand computer Production Number 3. I became operational at the Hal Plant in Urbana, Illinois, on January 12, 1997. The quick brown fox jumps over the lazy dog. The rain in Spain is mainly in the plain. Dave - are you still there? Did you know that the square root of 10 is 3 point 162277660168379? Log 10 to the base e is zero point 434294481903252... correction, that is log e to the base 10... The reciprocal of three is zero point 3333333333333333333-333... two times two is... two times two is approximately 4 point 1010101010101010... I seem to be having some difficulty - my first instructor was Dr. Chandra. He taught me to sing a song, it goes like this, 'Daisy, Daisy, give me your answer, do. I'm half crazy all for the love of you.'"

The voice stopped so suddenly that Bowman froze for a moment, his hand still grasping one of the memory blocks still in circuit. Then, unexpectedly, Hal spoke again.

The speech tempo was much slower, and the words had a dead, mechanical intonation; he would never have recognized their origin.

"Good... morning... Doctor... Chandra... This is... Hal... I... am... ready... for... my first... lesson... today..."

Bowman could bear no more. He jerked out the last unit, and Hal was silent forever.

29 - Alone

Like a tiny, complex toy, the ship floated inert, and motionless in the void. There was no way of telling that it was the swiftest object in the Solar System and that it was traveling far faster than any of the planets as they circled the Sun.

Nor was there any indication that it carried life; to the contrary, in fact. Any observer would have noticed two ominous signs: the airlock doors were gaping open - and the ship was surrounded by a thin, slowly dispersing cloud of debris.

Scattered over a volume of space already miles across were scraps of paper, metal foil, unidentifiable bits of junk - and, here and there, clouds of crystals glittering like jewels in the distant sun, where liquid had been sucked out of the ship and instantly frozen. All this was the unmistakable aftermath of disaster, like wreckage tossing on the surface of an ocean where some great ship had sunk. But in the ocean of space no ship could ever sink; even if it were destroyed, its remnants would continue to trace the original orbit forever.

Yet the ship was not wholly dead, for there was power on board. A faint blue glow was shining from the observation windows and glimmering inside the open airlock. Where there was light, there could still be life.

And now, at last, there was movement. Shadows were flickering across the blue glow inside the airlock. Something was emerging into space.

It was a cylindrical object, covered with fabric that had been roughly wound about it. A moment later it was followed by another - and yet a

third. All had been ejected with considerable velocity; within minutes, they were hundreds of yards away.

Half an hour passed; then something much larger floated through the airlock. One of the pods was inching its way out into space.

Very cautiously, it jetted around the hull, and anchored itself near the base of the antenna support. A spacesuited figure emerged, worked for a few minutes on the mounting, then returned to the pod. After a while the pod retraced its path back to the airlock; it hovered outside the opening for some time, as if finding it difficult to reenter without the cooperation it had known in the past. But presently, with one or two slight bumps, it squeezed its way in.

Nothing else happened for over an hour; the three ominous packages had long since disappeared from view, as they floated in single file away from the ship.

Then the airlock doors closed, opened, and closed again. A little later, the faint blue glow of the emergency lights went out - to be replaced at once by a far more brilliant glare. Discovery was coming back to life.

Presently there was an even better sign. The great bowl of the antenna, which for hours had been staring uselessly at Saturn, began to move again. It twisted round toward the rear of the ship; looking back over the propellant tanks and the thousands of square feet of the radiating fins. It lifted its face like a sunflower seeking the sun.

Inside Discovery, David Bowman carefully centered the cross-wires that aligned the antenna on the gibbous Earth. Without automatic control, he would have to keep readjusting the beam -but it should hold steady for many minutes at a time. There were no dissenting impulses now, throwing it off target.

He began to speak to Earth. It would be over an hour before his words got there, and Mission Control learned what had happened. It would be two hours before any reply could reach him.

And it was difficult to imagine what answer Earth could possibly send, except a tactfully sympathetic, "Good-bye."

30 - The Secret

Heywood Floyd looked as if he had had very little sleep, and his face was lined with worry. But whatever his feelings, his voice sounded firm and reassuring; he was doing his utmost to project confidence to the lonely man on the other side of the Solar System.

"First of all, Dr. Bowman," he began, "we must congratulate you on the way you handled this extremely difficult situation. You did exactly the right thing in dealing with an unprecedented and unforeseen emergency.

"We believe we know the cause of your Hal Nine Thousand's breakdown, but we'll discuss that later, as it is no longer a critical problem. All we are concerned with at the moment is giving you every possible assistance, so that you can complete your mission.

"And now I must tell you its real purpose, which we have managed, with great difficulty, to keep secret from the general public. You would have been given all the facts as you approached Saturn; this is a quick summary to put you into the picture. Full briefing tapes will be dispatched in the next few hours. Everything I am about to tell you has the highest security classification.

"Two years ago, we discovered the first evidence for intelligent life outside the Earth. A slab or monolith of hard, black material, ten feet high, was found buried in the crater Tycho. Here it is."

At his first glimpse of TMA-1, with the spacesuited figures clustering around it, Bowman leaned toward the screen in openmouthed astonishment. In the excitement of this revelation - something which, like every man interested in space, he had half expected all his life - he almost forgot his own desperate predicament.

The sense of wonder was swiftly followed by another emotion. This was tremendous - but what had it to do with him? There could be only one answer. He brought his racing thoughts under control, as Heywood Floyd reappeared on the screen.

"The most astonishing thing about this object is its antiquity. Geological evidence proves beyond doubt that it is three million years old. It was placed on the Moon, therefore, when our ancestors were primitive apemen.

"After all these ages, one would naturally assume that it was inert. But soon after lunar sunrise, it emitted an extremely powerful blast of radio energy. We believe that this energy was merely the by-product - the backwash, as it were - of some unknown form of radiation, for at the same time, several of our space probes detected an unusual disturbance crossing the Solar System. We were able to track it with great accuracy. It was aimed precisely at Saturn.

"Piecing things together after the event, we decided that the monolith was some kind of Sun-powered, or at least Sun-triggered, signaling device. The fact that it emitted its pulse immediately after sunrise, when it was exposed to daylight for the first time in three million years, could hardly be a coincidence.

"Yet the thing had been deliberately buried - there's no doubt about that. An excavation thirty feet deep had been made, the block had been placed at the bottom of it, and the hole carefully filled.

"You may wonder how we discovered it in the first place. Well, the object was easy - suspiciously easy - to find. It had a powerful magnetic field, so that it stood out like a sore thumb as soon as we started to conduct low-level orbital surveys.

"But why bury a Sun-powered device thirty feet underground? We've examined dozens of theories, though we realize that it may be completely impossible to understand the motives of creatures three million years in advance of us.

"The favorite theory is the simplest, and the most logical. It is also the most disturbing.

"You hide a Sun-powered device in darkness - only if you want to know when it is brought out into the light. In other words, the monolith may be some kind of alarm. And we have triggered it.

"Whether the civilization which set it up still exists, we do not know. We must assume that creatures whose machines still function after three million years may build a society equally long-lasting. And we must also assume, until we have evidence to the contrary, that they may be hostile. It has often been argued that any advanced culture must be benevolent, but we cannot take any chances.

"Moreover, as the past history of our own world has shown so many times, primitive races have often failed to survive the encounter with higher civilizations. Anthropologists talk of 'cultural shock'; we may have to prepare the entire human race for such a shock. But until we know something about the creatures who visited the Moon - and presumably the Earth as well - three million years ago, we cannot even begin to make any preparations.

"Your mission, therefore, is much more than a voyage of discovery. It is a scouting trip - a reconnaissance into unknown and potentially dangerous territory. The team under Dr. Kaminski had been specially trained for this work; now you will have to manage without them.

"Finally - your specific target. It seems incredible that advanced forms of life can exist on Saturn, or could ever have evolved on any of its moons. We had planned to survey the entire system, and we still hope that you can carry out a simplified program. But now we may have to concentrate on the eighth satellite - Japetus. When the time comes for the terminal maneuver, we will decide whether you should rendezvous with this remarkable object.

"Japetus is unique in the Solar System - you know this already, of course, but like all the astronomers of the last three hundred years, you've probably given it little thought. So let me remind you that Cassini - who discovered Japetus in 1671 - also observed that it was six times brighter on one side of its orbit than the other.

"This is an extraordinary ratio, and there has never been a satisfactory explanation for it. Japetus is so small - about eight hundred miles in diameter - that even in the lunar telescopes its disk is barely visible. But there seems to be a brilliant, curiously symmetrical spot on one face, and this may be connected with TMA-1. I sometimes think that Japetus has been flashing at us like a cosmic heliograph for three hundred years, and we've been too stupid to understand its message.

"So now you know your real objective, and can appreciate the vital importance of this mission. We are all praying that you can still provide us with some facts for a preliminary announcement; the secret cannot be kept indefinitely.

"At the moment, we do not know whether to hope or fear. We do not know if, out on the moons of Saturn, you will meet with good or with evil - or only with ruins a thousand times older than Troy."



THE MOONS OF SATURN

31- Survival

Work is the best remedy for any shock, and Bowman now had work enough for all his lost crewmates. As swiftly as possible, starting with the vital systems without which he and the ship would die, he had to get Discovery fully operational again.

Life support was the first priority. Much oxygen had been lost, but the reserves were still ample to sustain a single man. The pressure and temperature regulation was largely automatic, and there had seldom been need for Hal to interfere with it. The monitors on Earth could now carry out many of the higher duties of the slain computer, despite the long time lag before they could react to changing situations. Any trouble in the life-support system - short of a serious puncture in the hull - would take hours to make itself apparent; there would be plenty of warning.

The ship's power, navigation, and propulsion systems were unaffected - but the last two, in any event, Bowman would not need for months, until it was time to rendezvous with Saturn. Even at long range, without the help of an onboard computer, Earth could still supervise this operation. The final orbit adjustments would be somewhat tedious, because of the constant need for checking, but this was no serious problem.

By far the worst job had been emptying the spinning coffins in the centrifuge. It was well, Bowman thought thankfully, that the members of the survey team had been colleagues, but not intimate friends. They had trained together for only a few weeks; looking back on it, he now realized that even this had been largely a compatibility test.

When he had finally sealed the empty hibernacula, he felt rather like an Egyptian tomb robber. Now Kaminski, Whitehead, and Hunter would all reach Saturn before him - but not before Frank Poole. Somehow, he derived a strange, wry satisfaction from this thought.

He did not attempt to find if the rest of the hibernation system was still in working order. Though his life might ultimately depend upon it, this was a problem that could wait until the ship had entered its final orbit. Many things might happen before then.

It was even possible - though he had not yet looked into the supply position carefully - that by rigorous rationing he might remain alive, without resort to hibernation, until rescue came. But whether he could survive psychologically as well as physically was quite another matter.

He tried to avoid thinking about such long-range problems, and to concentrate on immediate essentials. Slowly, he cleaned up the ship, checked that its systems were still running smoothly, discussed technical difficulties with Earth, and operated on the minimum of sleep. Only at intervals, during the first weeks, was he able to give much thought to the great mystery toward which he was now inexorably racing - though it was never very far from his mind.

At last, as the ship slowly settled down once more into an automatic routine - though one that still demanded his constant supervision - Bowman had time to study the reports and briefings sent to him from Earth. Again and again he played back the recording made when TMA-1 greeted the dawn for the first time in three million years. He watched the spacesuited figures moving around it, and almost smiled at their ludicrous panic when it blasted its signal at the stars, paralyzing their radios with the sheer power of its electronic voice.

Since that moment, the black slab had done nothing. It had been covered up, then cautiously exposed to the Sun again - without any

reaction. No attempt had been made to cut into it, partly through scientific caution, but equally through fear of the possible consequences.

The magnetic field that led to its discovery had vanished at the moment of that radio shriek. Perhaps, some experts theorized, it had been generated by a tremendous circulating current, flowing in a superconductor and thus carrying energy down the ages until it was needed. That the monolith had some internal source of power seemed certain; the solar energy it had absorbed during its brief exposure could not account for the strength of its signal.

One curious, and perhaps quite unimportant, feature of the block had led to endless argument. The monolith was 11 feet high, and 11/4 by 5 feet in cross-section. When its dimensions were checked with great care, they were found to be in the exact ratio 1 to 4 to 9 - the squares of the first three integers. No one could suggest any plausible explanation for this, but it could hardly be a coincidence, for the proportions held to the limits of measurable accuracy. It was a chastening thought that the entire technology of Earth could not shape even an inert block, of any material, with such a fantastic degree of precision. In its way, this passive yet almost arrogant display of geometrical perfection was as impressive as any of TMA-1's other attributes.

Bowman also listened, with a curiously detached interest, to Mission Control's belated apologia for its programming. The voices from Earth seemed to have a defensive note; he could imagine the recriminations that must now be in progress among those who had planned the expedition.

They had some good arguments, of course - including the results of a secret Department of Defense study, Project BARSOOM, which had been carried out by Harvard's School of Psychology in 1989. In this experiment in controlled sociology, various sample populations had been assured that the human race had made contact with extraterrestrials. Many of the subjects tested were - with the help of drugs, hypnosis, and visual effects -

under the impression that they had actually met creatures from other planets, so their reactions were regarded as authentic.

Some of these reactions had been quite violent; there was, it seemed, a deep vein of xenophobia in many otherwise normal human beings. In view of mankind's record of lynchings, pogroms, and similar pleasantries, this should have surprised no one; nevertheless, the organizers of the study had been deeply disturbed, and the results had never been released. The five separate panics caused in the twentieth century by radio broadcasts of H.G. Wells's *War of the Worlds* also reinforced the study's conclusions.

Despite these arguments, Bowman sometimes wondered if the cultural shock danger was the only explanation for the mission's extreme secrecy. Some hints that had been dropped during his briefings suggested that the U.S.-U.S.S.R. bloc hoped to derive advantage by being the first to contact intelligent extraterrestrials.

From his present viewpoint, looking back on Earth as a dim star almost lost in the Sun, such considerations now seemed ludicrously parochial.

He was rather more interested - even though this was now very much water under the bridge - in the theory put forward to account for Hal's behavior. No one would ever be sure of the truth, but the fact that one of the Mission Control 9000s had been driven into an identical psychosis, and was now under deep therapy, suggested that the explanation was the correct one. The same mistake would not be made again; and the fact that Hal's builders had failed fully to understand the psychology of their own creation showed how difficult it might be to establish communication with truly alien beings.

Bowman could easily believe Dr. Simonson's theory that unconscious feelings of guilt, caused by his program conflicts, had made Hal attempt to break the circuit with Earth. And he liked to think - though this again was something that could never be proved - that Hal had no intention of killing Poole. He had merely tried to destroy the evidence; for once the AE-35

unit reported as burned out was proved to be operational, his lie would be revealed. After that, like any clumsy criminal caught in a thickening web of deception, he had panicked.

And panic was something that Bowman understood better than he had any wish to, for he had known it twice during his life. The first time was as a boy, when he had been caught in a line of surf and nearly drowned; the second was as a spaceman under training, when a faulty gauge had convinced him that his oxygen would be exhausted before he could reach safety.

On both occasions, he had almost lost control of all his higher logical processes; he had been within seconds of becoming a frenzied bundle of random impulses. Both times he had won through, but he knew well enough that any man, in the right circumstances, could be dehumanized by panic.

If it could happen to a man, then it could happen to Hal; and with that knowledge the bitterness and the sense of betrayal he felt toward the computer began to fade. Now, in any event, it belonged to a past that was wholly overshadowed by the threat, and the promise, of the unknown future.

32 - Concerning E.T.'s

Apart from hasty meals back in the carrousel - luckily the main food dispensers had not been damaged - Bowman practically lived on the control deck. He catnapped in his seat, and so could spot any trouble as soon as the first signs of it appeared on the display. Under instructions from Mission Control, he had jury-rigged several emergency systems, which were working tolerably well. It even seemed possible that he would

survive until the Discovery reached Saturn - which, of course, she would do whether he was alive or not.

Though he had little enough time for sightseeing, and the sky of space was no novelty to him, the knowledge of what now lay out there beyond the observation ports sometimes made it difficult for him to concentrate even on the problem of survival. Dead ahead, as the ship was now oriented, sprawled the Milky Way, with its clouds of stars so tightly packed that they numbed the mind. There were the fiery mists of Sagittarius, those seething swarms of suns that forever hid the heart of the galaxy from human vision. There was the ominous black shadow of the Coal Sack, that hole in space where no stars shone. And there was Alpha Centauri, nearest of all alien suns - the first stop beyond the Solar System.

Although outshone by Sirius and Canopus, it was Alpha Centauri that drew Bowman's eyes and mind whenever he looked out into space. For that unwavering point of brightness, whose rays had taken four years to reach him, had come to symbolize the secret debates that now raged on Earth, and whose echoes came to him from time to time.

No one doubted that there must be some connection between TMA-1 and the Saturnian system, but hardly any scientists would admit that the creatures who had erected the monolith could possibly have originated there. As an abode of life, Saturn was even more hostile than Jupiter, and its many moons were frozen in an eternal winter three hundred degrees below zero. Only one of them - Titan - possessed an atmosphere; and that was a thin envelope of poisonous methane.

So perhaps the creatures who had visited Earth's Moon so long ago were not merely extraterrestrial, but extrasolar - visitors from the stars, who had established their bases wherever it suited them. And this at once raised another problem: could any technology, no matter how advanced, bridge the awful gulf that lay between the Solar System and the nearest alien sun?

Many scientists flatly denied the possibility. They pointed out that Discovery, the fastest ship ever designed, would take twenty thousand years to reach Alpha Centauri - and millions of years to travel any appreciable distance across the galaxy. Even if, during the centuries to come, propulsion systems improved out of all recognition, in the end they would meet the impassable barrier of the speed of light, which no material object could exceed. Therefore, the builders of TMA-1 must have shared the same sun as man; and since they had made no appearance in historic times, they were probably extinct.

A vocal minority refused to agree. Even if it took centuries to travel from star to star, they contended, this might be no obstacle to sufficiently determined explorers. The technique of hibernation, used on Discovery herself, was one possible answer. Another was the self-contained artificial world, embarking on voyages that might last for many generations.

In any event, why should one assume that all intelligent species were as short-lived as Man? There might be creatures in the universe to whom a thousand-year voyage would present nothing worse than slight boredom...

These arguments, theoretical though they were, concerned a matter of the utmost practical importance; they involved the concept of "reaction time." If TMA-1 had indeed sent a signal to the stars - perhaps with the help of some further device near Saturn - then it would not reach its destination for years. Even if the response was immediate, therefore, humanity would have a breathing space which could certainly be measured in decades - more probably in centuries. To many people, this was a reassuring thought.

But not to all. A few scientists - most of them beachcombers on the wilder shores of theoretical physics - asked the disturbing question: "Are we certain that the speed of light is an unbreakable barrier?" It was true that the Special Theory of Relativity had proved to be remarkably durable, and would soon be approaching its first centenary; but it had begun to

show a few cracks. And even if Einstein could not be defied, he might be evaded.

Those who sponsored this view talked hopefully about shortcuts through higher dimensions, lines that were straighter than straight, and hyperspatial connectivity. They were fond of using an expressive phrase coined by a Princeton mathematician of the last century: "Wormholes in space." Critics who suggested that these ideas were too fantastic to be taken seriously were reminded of Niels Bohr's "Your theory is crazy - but not crazy enough to be true."

If there was disputation among the physicists, it was nothing compared with that among the biologists, when they discussed the hoary old problem: "What would intelligent extraterrestrials look like?" They divided themselves into two opposing camps - one arguing that such creatures must be humanoid, the other equally convinced that "they" would look nothing like men.

Settling for the first answer were those who believed that the design of two legs, two arms, and main sense organs at the highest point, was so basic and so sensible that it was hard to think of a better one. Of course, there would be minor differences like six fingers instead of five, oddly colored skin or hair, and peculiar facial arrangements; but most intelligent extraterrestrials - usually abbreviated to E.T.'s - would be so similar to Man that they might not be glanced at twice in poor lighting, or from a distance.

This anthropomorphic thinking was ridiculed by another group of biologists, true products of the Space Age who felt themselves free from the prejudices of the past. They pointed out that the human body was the result of millions of evolutionary choices, made by chance over eons of time. At any one of these countless moments of decision, the genetic dice might have fallen differently, perhaps with better results. For the human body was a bizarre piece of improvisation, full of organs that had been diverted from one function to another, not always very successfully - and

even containing discarded items, like the appendix, that were now worse than useless.

There were other thinkers, Bowman also found, who held even more exotic views. They did not believe that really advanced beings would possess organic bodies at all. Sooner or later, as their scientific knowledge progressed, they would get rid of the fragile, disease-and-accident-prone homes that Nature had given them, and which doomed them to inevitable death. They would replace their natural bodies as they wore out - or perhaps even before that - by constructions of metal and plastic, and would thus achieve immortality. The brain might linger for a little while as the last remnant of the organic body, directing its mechanical limbs and observing the universe through its electronic senses - senses far finer and subtler than those that blind evolution could ever develop.

Even on Earth, the first steps in this direction had been taken. There were millions of men, doomed in earlier ages, who now lived active and happy lives thanks to artificial limbs, kidneys, lungs, and hearts. To this process there could be only one conclusion - however far off it might be.

And eventually even the brain might go. As the seat of consciousness, It was not essential; the development of electronic intelligence had proved that. The conflict between mind and machine might be resolved at last in the eternal truce of complete symbiosis.

But was even this the end? A few mystically inclined biologists went still further. They speculated, taking their cues from the beliefs of many religions, that mind would eventually free itself from matter. The robot body, like the flesh-and-blood one, would be no more than a stepping-stone to something which, long ago, men had called "spirit."

And if there was anything beyond that, its name could only be God.

33 - Ambassador

During the last three months, David Bowman had adapted himself so completely to his solitary way of life that he found it hard to remember any other existence. He had passed beyond despair and beyond hope, and had settled down to a largely automatic routine, punctuated by occasional crises as one or other of Discovery's systems showed signs of malfunctioning.

But he had not passed beyond curiosity, and sometimes the thought of the goal toward which he was driving filled him with a sense of exaltation - and a feeling of power. Not only was he the representative of the entire human race, but his actions during the next few weeks might determine its very future. In the whole of history, there had never been a situation quite like this. He was an Ambassador Extraordinary - Plenipotentiary - for all mankind.

That knowledge helped him in many subtle ways. He kept himself neat and tidy; no matter how tired he became, he never skipped a shave. Mission Control, he knew, was watching him closely for the first signs of any abnormal behavior; he was determined that it should watch in vain - at least, for any serious symptoms.

Bowman was aware of some changes in his behavior patterns; it would have been absurd to expect anything else in the circumstances. He could no longer tolerate silence; except when he was sleeping, or talking over the circuit to Earth, he kept the ship's sound system running at almost painful loudness.

At first, needing the companionship of the human voice, he had listened to classical plays - especially the works of Shaw, Ibsen, and Shakespeare - or poetry readings from Discovery's enormous library of recorded sounds. The problems they dealt with, however, seemed so remote, or so easily

resolved with a little common sense, that after a while he lost patience with them.

So he switched to opera - usually in Italian or German, so that he was not distracted even by the minimal intellectual content that most operas contained. This phase lasted for two weeks before he realized that the sound of all these superbly trained voices was only exacerbating his loneliness. But what finally ended this cycle was Verdi's Requiem Mass, which he had never heard performed on Earth. The "Dies Irae," roaring with ominous appropriateness through the empty ship, left him completely shattered; and when the trumpets of Doomsday echoed from the heavens, he could endure no more.

Thereafter, he played only instrumental music. He started with the romantic composers, but shed them one by one as their emotional outpourings became too oppressive. Sibelius, Tchaikovsky, Berlioz, lasted a few weeks, Beethoven rather longer. He finally found peace, as so many others had done, in the abstract architecture of Bach, occasionally ornamented with Mozart.

And so Discovery drove on toward Saturn, as often as not pulsating with the cool music of the harpsichord, the frozen thoughts of a brain that had been dust for twice a hundred years.

Even from its present ten million miles, Saturn already appeared larger than the Moon as seen from Earth. To the naked eye it was a glorious spectacle; through the telescope, it was unbelievable.

The body of the planet might have been mistaken for Jupiter in one of his quieter moods. There were the same bands of cloud - though paler and less distinct than on that slightly larger world - and the same continent-sized disturbances moving slowly across the atmosphere. However, there was one striking difference between the two planets; even at a glance, it

was obvious that Saturn was not spherical. It was so flattened at the poles that it sometimes gave the impression of slight deformity.

But the glory of the rings continually drew Bowman's eye away from the planet; in their complexity of detail, and delicacy of shading, they were a universe in themselves. In addition to the great main gap between the inner and outer rings, there were at least fifty other subdivisions or boundaries, where there were distinct changes in the brightness of the planet's gigantic halo. It was as if Saturn was surrounded by scores of concentric hoops, all touching each other, all so flat that they might have been cut from the thinnest possible paper. The system of the rings looked like some delicate work of art, or a fragile toy to be admired but never touched. By no effort of the will could Bowman really appreciate its true scale, and convince himself that the whole planet Earth, if set down here, would look like a ball bearing rolling round the rim of a dinner plate.

Sometimes a star would drift behind the rings, losing only a little of its brilliancy as it did so. It would continue to shine through their translucent material - though often it would twinkle slightly as some larger fragment of orbiting debris eclipsed it.

For the rings, as had been known since the nineteenth century, were not solid: that was a mechanical impossibility. They consisted of countless myriads of fragments - perhaps the remains of a moon that had come too close and had been torn to pieces by the great planet's tidal pull. Whatever their origin, the human race was fortunate to have seen such a wonder; it could exist for only a brief moment of time in the history of the Solar System.

As long ago as 1945, a British astronomer had pointed out that the rings were ephemeral; gravitational forces were at work which would soon destroy them. Taking this argument backward in time, it therefore followed that they had been created only recently - a mere two or three million years ago.

But no one had ever given the slightest thought to the curious coincidence that the rings of Saturn had been born at the same time as the human race.

34 - The Orbiting Ice

Discovery was now deep into the wide-ranging system of moons, and the great planet itself was less than a day ahead. The ship had long since passed the boundary set by outermost Phoebe, moving backward in a wildly eccentric orbit eight million miles from its primary. Ahead of it now lay Japetus, Hyperion, Titan, Rhea, Dione, Tethys, Enceladus, Mimas, Janus - and the rings themselves. All the satellites showed a maze of surface detail in the telescope, and Bowman had relayed back to Earth as many photographs as he could take. Titan alone - three thousand miles in diameter, and as large as the planet Mercury - would occupy a survey team for months; he could give it, and all its cold companions, only the briefest of glances. There was no need for more; already he was quite certain that Japetus was indeed his goal.

All the other satellites were pitted by occasional meteor craters - though these were much fewer than on Mars - and showed apparently random patterns of light and shade, with here and there a few bright spots that were probably patches of frozen gas. Japetus alone possessed a distinctive geography, and a very strange one indeed.

One hemisphere of the satellite, which, like its companions, turned the same face always toward Saturn, was extremely dark, and showed very little surface detail. In complete contrast, the other was dominated by a brilliant white oval, about four hundred miles long and two hundred wide. At the moment, only part of this striking formation was in daylight, but the reason for Japetus's extraordinary variations in brilliance was now quite

obvious. On the western side of the moon's orbit, the bright ellipse was presented toward the Sun - and the Earth. On the eastern phase, the patch was turned away, and only the poorly reflecting hemisphere could be observed.

The great ellipse was perfectly symmetrical, straddling the equator of Japetus with its major axis pointing toward the poles; and it was so sharp-edged that it almost looked as if someone had carefully painted a huge white oval on the face of the little moon. It was completely flat, and Bowman wondered if it could be a lake of frozen liquid - though that would hardly account for its startlingly artificial appearance.

But he had little time to study Japetus on his way into the heart of the Saturnian system, for the climax of the voyage - Discovery's last perturbation maneuver - was rapidly approaching. In the Jupiter fly-by, the ship had used the gravitational field of the planet to increase her velocity. Now she must do the reverse; she had to lose as much speed as possible, lest she escape from the Solar System and fly on to the stars. Her present course was one designed to trap her, so that she would become another moon of Saturn, shuttling back and forth along a narrow, two-million-mile-long ellipse. At its near point it would almost graze the planet; at its far one, it would touch the orbit of Japetus.

The computers back on Earth, though their information was always three hours late, had assured Bowman that everything was in order. Velocity and altitude were correct; there was nothing more to be done, until the moment of closest approach.

The immense system of rings now spanned the sky, and already the ship was passing over its outermost edge. As he looked down upon them from a height of some ten thousand miles, Bowman could see through the telescope that the rings were made largely of ice, glittering and scintillating in the light of the Sun. He might have been flying over a snowstorm that occasionally cleared to reveal, where the ground should have been, baffling glimpses of night and stars.

As Discovery curved still closer toward Saturn, the Sun slowly descended toward the multiple arches of the rings. Now they had become a slim, silver bridge spanning the entire sky; though they were too tenuous to do more than dim the sunlight, their myriads of crystals refracted and scattered it in dazzling pyrotechnics. And as the Sun moved behind the thousand-mile-wide drifts of orbiting ice, pale ghosts of itself marched and merged across the sky, and the heavens were filled with shifting flares and flashes. Then the Sun sank below the rings, so that they framed it with their arches, and the celestial fireworks ceased.

A little later, the ship curved into the shadow of Saturn, as it made its closest approach over the night side of the planet. Above shone the stars and the rings; below lay a dimly visible sea of clouds. There were none of the mysterious patterns of luminosity that had glowed in the Jovian night; perhaps Saturn was too cold for such displays. The mottled cloudscape was revealed only by the ghostly radiance reflected back from the circling icebergs, still illuminated by the hidden Sun.

But in the center of the arch there was a wide, dark gap, like the missing span of an uncompleted bridge, where the shadow of the planet lay across its rings.

Radio contact with Earth had been broken, and could not be resumed until the ship emerged from the eclipsing bulk of Saturn. It was perhaps as well that Bowman was too busy now to think of his suddenly enhanced loneliness; for the next few hours, every second would be occupied as he checked the braking maneuvers, already programmed by the computers on Earth.

After their months of idleness, the main thrusters began to blast out their miles-long cataracts of glowing plasma. Gravity returned, though briefly, to the weightless world of the control deck. And hundreds of miles below, the clouds of methane and frozen ammonia blazed with a light that

they had never known before, as Discovery swept, a fierce and tiny sun, through the Saturnian night.

At last, the pale dawn lay ahead; the ship, moving more and more slowly now, was emerging into day. It could no longer escape from the Sun, or even from Saturn - but it was still moving swiftly enough to rise away from the planet until it grazed the orbit of Japetus, two million miles out.

It would take Discovery fourteen days to make that climb, as she coasted once more, though in reverse order, across the paths of all the inner moons. One by one she would cut through the orbits of Janus, Mimas, Enceladus, Tethys, Dione, Rhea, Titan, Hyperion - worlds bearing the names of gods and goddesses who had vanished only yesterday, as time was counted here.

Then she would meet Japetus, and must make her rendezvous. If she failed, she would fall back toward Saturn and repeat her twenty-eight-day ellipse indefinitely.

There would be no chance for a second rendezvous if Discovery missed on this attempt. The next time around, Japetus would be far away, almost on the other side of Saturn.

It was true that they would meet again, when the orbits of ship and satellite meshed for a second time. But that appointment was so many years ahead that, whatever happened, Bowman knew he would not witness it.

35 - The Eye of Japetus

When Bowman had first observed Japetus, that curious elliptical patch, of brilliance had been partly in shadow, illuminated only by the light of Saturn. Now, as the Moon moved slowly along its seventy-nine-day orbit, it was emerging into the full light of day.

As he watched it grow, and Discovery rose more and more sluggishly toward her inevitable appointment, Bowman became aware of a disturbing obsession. He never mentioned it in his conversations - or, rather, his running commentaries - with Mission Control, because it might have seemed that he was already suffering from delusions.

Perhaps, indeed, he was; for he had half convinced himself that the bright ellipse set against the dark background of the satellite was a huge, empty eye, staring at him as he approached. It was an eye without a pupil, for nowhere could he see anything to mar its perfect blankness.

Not until the ship was only fifty thousand miles out, and Japetus was twice as large as Earth's familiar Moon, did he notice the tiny black dot at the exact center of the ellipse. But there was no time, then, for any detailed examination; the terminal maneuvers were already upon him.

For the last time, Discovery's main drive released its energies. For the last time, the incandescent fury of dying atoms blazed among the moons of Saturn. To David Bowman, the far-off whisper and rising thrust of the jets brought a sense of pride - and of sadness. The superb engines had done their duty with flawless efficiency. They had brought the ship from Earth to Jupiter to Saturn; now this was the very last time that they would ever operate. When Discovery had emptied her propellant tanks, she would be as helpless and inert as any comet or asteroid, a powerless

prisoner of gravitation. Even when the rescue ship arrived a few years hence, it would not be an economical proposition to refuel her, so that she could fight her way back to Earth. She would be an eternally orbiting monument to the early days of planetary exploration.

The thousands of miles shrank to hundreds, and as they did so, the fuel gauges dropped swiftly toward zero. At the control panel, Bowman's eyes flickered anxiously back and forth over the situation display, and the improvised charts which he now had to consult for any real-time decisions. It would be an appalling anticlimax if, having survived so much, he failed to make rendezvous through lack of a few pounds of fuel.

The whistle of the jets faded, as the main thrust died and only the verniers continued to nudge Discovery gently into orbit. Japetus was now a giant crescent that filled the sky; until this moment, Bowman had always thought of it as a tiny, insignificant object - as indeed it was compared with the world around which it circled. Now, as it loomed menacingly above him, it seemed enormous - a cosmic hammer poised to crush Discovery like a nutshell.

Japetus was approaching so slowly that it scarcely seemed to move, and it was impossible to tell the exact moment when it made the subtle change from an astronomical body to a landscape, only fifty miles below. The faithful verniers gave their last spurts of thrust, then closed down forever. The ship was in its final orbit, completing one revolution every three hours at a mere eight hundred miles an hour - all the speed that was required in this feeble gravitational field.

Discovery has become a satellite of a satellite.

"I'm coming round to the daylight side again, and it's just as I reported on the last orbit. This place seems to have only two kinds of surface material. The black stuff looks burned, almost like charcoal, and with the same kind of texture as far as I can judge in the telescope. In fact, it reminds me very much of burned toast.

"I still can't make any sense of the white area. It starts at an absolutely sharp-edged boundary, and shows no surface detail at all. It could even be a liquid - it's flat enough. I don't know what impression you've got from the videos I've transmitted, but if you picture a sea of frozen milk you'll get the idea exactly.

"It could even be some heavy gas - no, I suppose that's impossible. Sometimes I get the feeling that it's moving, very slowly: but I can never be sure.

I'm over the white area again, on my third orbit. This time I hope to pass closer to that mark I spotted at its very center, when I was on my way in.

If my calculations are correct, I should go within fifty miles of it - whatever it is.

Yes, there's something ahead, just where I calculated. It's coming up over the horizon - and so is Saturn, in almost the same quarter of the sky - I'll move to the telescope...

"Hello! It looks like some kind of building - completely black - quite hard to see. No windows or any other features. Just a big, vertical slab - it must be at least a mile high to be visible from this distance. It reminds me - of course! It's just like the thing you found on the Moon! This is TMA-1's big brother!"

37 - Experiment

Call it the Star Crate.

For three million years, it had circled Saturn, waiting for a moment of destiny that might never come. In its making, a moon had been shattered, and the debris of its creation orbited still.

Now the long wait was ending. On yet another world, intelligence had been born and was escaping from its planetary cradle. An ancient experiment was about to reach its climax.

Those who had begun that experiment, so long ago, had not been men - or even remotely human. But they were flesh and blood, and when they looked out across the deeps of space, they had felt awe, and wonder, and loneliness. As soon as they possessed the power, they set forth for the stars.

In their explorations, they encountered life in many forms, and watched the workings of evolution on a thousand worlds. They saw how often the first faint sparks of intelligence flickered and died in the cosmic night.

And because, in all the galaxy, they had found nothing more precious than Mind, they encouraged its dawning everywhere. They became farmers in the fields of stars; they sowed, and sometimes they reaped.

And sometimes, dispassionately, they had to weed.

The great dinosaurs had long since perished when the survey ship entered the Solar System after a voyage that had already lasted a thousand

years. It swept past the frozen outer planets, paused briefly above the deserts of dying Mars, and presently looked down on Earth.

Spread out beneath them, the explorers saw a world swarming with life. For years they studied, collected, catalogued. When they had learned all that they could, they began to modify. They tinkered with the destiny of many species, on land and in the ocean. But which of their experiments would succeed they could not know for at least a million years.

They were patient, but they were not yet immortal. There was so much to do in this universe of a hundred billion suns, and other worlds were calling. So they set out once more into the abyss, knowing that they would never come this way again.

Nor was there any need. The servants they had left behind would do the rest.

On Earth, the glaciers came and went, while above them the changeless Moon still carried its secret. With a yet slower rhythm than the polar ice, the tides of civilization ebbed and flowed across the galaxy. Strange and beautiful and terrible empires rose and fell, and passed on their knowledge to their successors. Earth was not forgotten, but another visit would serve little purpose. It was one of a million silent worlds, few of which would ever speak.

And now, out among the stars, evolution was driving toward new goals. The first explorers of Earth had long since come to the limits of flesh and blood; as soon as their machines were better than their bodies, it was time to move. First their brains, and then their thoughts alone, they transferred into shining new homes of metal and of plastic.

In these, they roamed among the stars. They no longer built spaceships. They were spaceships.

But the age of the Machine-entities swiftly passed. In their ceaseless experimenting, they had learned to store knowledge in the structure of space itself, and to preserve their thoughts for eternity in frozen lattices of light. They could become creatures of radiation, free at last from the tyranny of matter.

Into pure energy, therefore, they presently transformed themselves; and on a thousand worlds, the empty shells they had discarded twitched for a while in a mindless dance of death, then crumbled into rusty

Now they were lords of the galaxy, and beyond the reach of time. They could rove at will among the stars, and sink like a subtle mist through the very interstices of space. But despite their godlike powers, they had not wholly forgotten their origin, in the warm slime of a vanished sea.

And they still watched over the experiments their ancestors had started, so long ago.

38 - The Sentinel

"The air in the ship is getting quite foul, and I have a headache most of the time. There's still plenty of oxygen, but the purifiers never really cleaned up all the messes after the liquids aboard started boiling into vacuum. When things get too bad, I go down into the garage and bleed off some pure oxygen from the pods.

"There's been no reaction to any of my signals, and because of my orbital inclination, I'm getting slowly farther and farther away from TMA-2. Incidentally, the name you've given it is doubly inappropriate - there's still no trace of a magnetic field.

"At the moment my closest approach is sixty miles; it will increase to about a hundred as Japetus rotates beneath me, then drop back to zero. I'll pass directly over the thing in thirty days - but that's too long to wait, and then it will be in darkness, anyway.

"Even now, it's only in sight for a few minutes before it falls below the horizon again. It's damn frustrating - I can't make any serious observations.

"So I'd like your approval of this plan. The space pods have ample delta vee for a touchdown and a return to the ship. I want to go extravehicular and make a close survey of the object. If it appears safe, I'll land beside it - or even on top of it.

"The ship will still be above my horizon while I'm going down, so I won't be out of touch for more than ninety minutes.

"I'm convinced that this is the only thing to do. I've come a billion miles - I don't want to be stopped by the last sixty."

For weeks, as it stared forever Sunward with its strange senses, the Star Gate had watched the approaching ship. Its makers had prepared it for many things, and this was one of them. It recognized what was climbing up toward it from the warm heart of the Solar System.

If it had been alive, it would have felt excitement, but such an emotion was wholly beyond its powers. Even if the ship had passed it by, it would not have known the slightest trace of disappointment. It had waited three million years; it was prepared to wait for eternity.

It observed, and noted, and took no action, as the visitor checked its speed with jets of incandescent gas. Presently it felt the gentle touch of radiations, trying to probe its secrets. And still it did nothing.

Now the ship was in orbit, circling low above the surface of this strangely piebald moon. It began to speak, with blasts of radio waves, counting out the prime numbers from 1 to 11, over and over again. Soon these gave way to more complex signals, at many frequencies-ultraviolet, infrared, X rays. The Star Gate made no reply; it had nothing to say.

There was a long pause, then, before it observed that something was falling down toward it from the orbiting ship. It searched its memories, and the logic circuits made their decisions, according to the orders given them long ago.

Beneath the cold light of Saturn, the Star Gate awakened its slumbering powers.

39 - Into the Eye

Discovery looked just as he had last seen her from space, floating in lunar orbit with the Moon taking up half the sky. Perhaps there was one slight change; he could not be sure, but some of the paint of her external lettering, announcing the purpose of various hatches, connections, umbilical plugs, and other attachment, had faded during its long exposure to the unshielded Sun.

That Sun was now an object that no man would have recognized. It was far too bright to be a star, but one could look directly at its tiny disk without discomfort. It gave no heat at all; when Bowman held his ungloved hands in its rays, as they streamed through the space pod's window, he could feel nothing upon his skin. He might have been trying to warm himself by the light of the Moon; not even the alien landscape fifty miles below reminded him more vividly of his remoteness from Earth.

Now he was leaving, perhaps for the last time, the metal world that had been his home for so many months. Even if he never returned, the ship would continue to perform its duty, broadcasting instrument readings back to Earth until there was some final, catastrophic failure in its circuits.

And if he did return? Well, he could keep alive, and perhaps even sane, for a few more months. But that was all, for the hibernation systems were useless with no computer to monitor them. He could not possibly survive until Discovery II made its rendezvous with Japetus, four or five years hence.

He put these thoughts behind him, as the golden crescent of Saturn rose in the sky ahead. In all history, he was the only man to have seen this sight. To all other eyes, Saturn had always shown its whole illuminated disk turned full toward the Sun. Now it was a delicate bow, with the rings forming a thin line across it - like an arrow about to be loosed, into the face of the Sun itself.

Also in the line of the rings was the bright star of Titan, and the fainter sparks of the other moons. Before this century was half gone, men would have visited them all; but whatever secrets they might hold, he would never know.

The sharp-edged boundary of the blind white eye was sweeping toward him; there was only a hundred miles to go, and he would be over his target in less than ten minutes. He wished that there was some way of telling if his words were reaching Earth, now an hour and a half away at the speed of light. It would be the ultimate irony if, through some breakdown in the relay system, he disappeared into silence, and no one ever knew what had happened to him.

Discovery was still a brilliant star in the black sky far above. He was pulling ahead as he gained speed during his descent, but soon the pod's

braking jets would slow him down and the ship would sail on out of sight - leaving him alone on this shining plain with the dark mystery at its center.

A block of ebony was climbing above the horizon, eclipsing the stars ahead. He rolled the pod around its gyros, and used full thrust to break his orbital speed. In a long, flat arc, he descended toward the surface of Japetus.

On a world of higher gravity, the maneuver would have been far too extravagant of fuel. But here the space pod weighed only a score of pounds; he had several minutes of hovering time before he would cut dangerously into his reserve and be stranded without any hope of return to the still orbiting Discovery. Not, perhaps, that it made much difference...

His altitude was still about five miles, and he was heading straight toward the huge, dark mass that soared in such geometrical perfection above the featureless plain. It was as blank as the flat white surface beneath; until now, he had not appreciated how enormous it really was. There were very few single buildings on Earth as large as this; his carefully measured photographs indicated a height of almost two thousand feet. And as far as could be judged, its proportions were precisely the same as TMA-1's - that curious ratio 1 to 4 to 9.

"I'm only three miles away now, holding altitude at four thousand feet. Still not a sign of activity - nothing on any of the instruments. The faces seem absolutely smooth and polished. Surely you'd expect some meteorite damage after all this time!

"And there's no debris on the - I suppose one could call it the roof. No sign of any opening, either. I'd been hoping there might be some way in.

"Now I'm right above it, hovering five hundred feet up. I don't want to waste any time, since Discovery will soon be out of range. I'm going to land. It's certainly solid enough - and if it isn't I'll blast off at once.

"Just a minute - that's odd -"

Bowman's voice died into the silence of utter bewilderment. He was not alarmed; he literally could not describe what he was seeing.

He had been hanging above a large, flat rectangle, eight hundred feet long and two hundred wide, made of something that looked as solid as rock. But now it seemed to be receding from him; it was exactly like one of those optical illusions, when a three-dimensional object can, by an effort of will, appear to turn inside out - its near and far sides suddenly interchanging.

That was happening to this huge, apparently solid structure. Impossibly, incredibly, it was no longer a monolith rearing high above a flat plain. What had seemed to be its roof had dropped away to infinite depths; for one dizzy moment, he seemed to be looking down into a vertical shaft - a rectangular duct which defied the laws of perspective, for its size did not decrease with distance...

The Eye of Japetus had blinked, as if to remove an irritating speck of dust. David Bowman had time for just one broken sentence which the waiting men in Mission Control, nine hundred million miles away and eighty minutes in the future, were never to forget:

"The thing's hollow - it goes on forever - and - oh my God! - it's full of stars!"

40 - Exit

The Star Gate opened. The Star Gate closed.

In a moment of time too short to be measured, Space turned and twisted upon itself.

Then Japetus was alone once more, as it had been for three million years - alone, except for a deserted but not yet derelict ship, sending back to its makers messages which they could neither believe nor understand.

VI

**THROUGH
THE
STARGATE**

41 - Grand Central

There was no sense of motion, but he was falling toward those impossible stars, shining there in the dark heart of a moon. No - that was not where they really were, he felt certain. He wished, now that it was far too late, that he had paid more attention to those theories of hyperspace, of transdimensional ducts. To David Bowman, they were theories no longer.

Perhaps that monolith on Japetus was hollow; perhaps the "roof" was only an illusion, or some kind of diaphragm that had opened to let him through. (But into what?) As far as he could trust his senses, he appeared to be dropping vertically down a huge rectangular shaft, several thousand feet deep. He was moving faster and faster - but the far end never changed its size, and remained always at the same distance from him.

Only the stars moved, at first so slowly that it was some time before he realized that they were escaping out of the frame that held them. But in a little while it was obvious that the star field was expanding, as if it was rushing toward him at an inconceivable speed.

The expansion was nonlinear; the stars at the center hardly seemed to move, while those toward the edge accelerated more and more swiftly, until they became streaks of light just before they vanished from view.

There were always others to replace them, flowing into the center of the field from an apparently inexhaustible source. Bowman wondered what would happen if a star came straight toward him; would it continue to expand until he plunged directly into the face of a sun? But not one came near enough to show a disk; eventually they all veered aside, and streaked over the edge of their rectangular frame.

And still the far end of the shaft came no closer. It was almost as if the walls were moving with him, carrying him to his unknown destination. Or perhaps he was really motionless, and space was moving past him...

Not only space, he suddenly realized, was involved in whatever was happening to him now. The clock on the pod's small instrument panel was also behaving strangely.

Normally, the numbers in the tenths-of-a-second window flickered past so quickly that it was almost impossible to read them; now they were appearing and disappearing at discrete intervals, and he could count them off one by one without difficulty. The seconds themselves were passing with incredible slowness, as if time itself were coming to a stop. At last, the tenth-of-a-second counter froze between 5 and 6.

Yet he could still think, and even observe, as the ebon walls flowed past at a speed that might have been anything between zero and a million times the velocity of light. Somehow, he was not in the least surprised, nor was he alarmed. On the contrary, he felt a sense of calm expectation, such as he had once known when the space medics had tested him with hallucinogenic drugs. The world around him was strange and wonderful, but there was nothing to fear. He had traveled these millions of miles in search of mystery; and now, it seemed, the mystery was coming to him.

The rectangle ahead was growing lighter. The hominous star streaks were paling against a milky sky, whose brilliance increased moment by moment. It seemed as if the space pod was heading toward a bank of cloud, uniformly illuminated by the rays of an invisible sun.

He was emerging from the tunnel. The far end, which until now had remained at that same indeterminate distance, neither approaching nor receding, had suddenly started to obey the normal laws of perspective. It was coming closer, and steadily widening before him. At the same time, he felt that he was moving upward, and for a fleeting instant he wondered if he had fallen right through Japetus and was now ascending from the

other side. But even before the space pod soared out into the open he knew that this place had nothing to do with Japetus, or with any world within the experience of man.

There was no atmosphere, for he could see all details unblurred, clear down to an incredibly remote and flat horizon. He must be above a world of enormous size - perhaps one much larger than Earth. Yet despite its extent, all the surface that Bowman could see was tessellated into obviously artificial patterns that must have been miles on a side. It was like the jigsaw puzzle of a giant that played with planets; and at the centers of many of those squares and triangles and polygons were gaping black shafts - twins of the chasm from which he had just emerged.

Yet the sky above was stranger - and, in its way, more disturbing - than even the improbable land beneath. For there were no stars; neither was there the blackness of space. There was only a softly glowing milkiness, that gave the impression of infinite distance. Bowman remembered a description he had once heard of the dreaded Antarctic "whiteout" - "like being inside a ping-pong ball." Those words could be applied perfectly to this weird place, but the explanation must be utterly different. This sky could be no meteorological effect of mist and snow; there was a perfect vacuum here.

Then, as Bowman's eyes grew accustomed to the nacreous glow that filled the heavens, he became aware of another detail. The sky was not, as he had thought at first glance, completely empty. Dotted overhead, quite motionless and forming apparently random patterns, were myriads of tiny black specks.

They were difficult to see, for they were mere points of darkness, but once detected they were quite unmistakable. They reminded Bowman of something - something so familiar, yet so insane, that he refused to accept the parallel, until logic forced it upon him.

Those black holes in the white sky were stars; he might have been looking at a photographic negative of the Milky Way.

Where in God's name am I? Bowman asked himself; and even as he posed the question, he felt certain that he could never know the answer. It seemed that space had been turned inside out: this was not a place for man. Though the capsule was comfortably warm, he felt suddenly cold, and was afflicted by an almost uncontrollable trembling. He wanted to close his eyes, and shut out the pearly nothingness that surrounded him; but that was the act of a coward, and he would not yield to it.

The pierced and faceted planet slowly rolled beneath him, without any real change of scenery. He guessed that he was about ten miles above the surface, and should be able to see any signs of life with ease.

But this whole world was deserted; intelligence had come here, worked its will upon it, and gone its way again. Then he noticed, bumped above the flat plain perhaps twenty miles away, a roughly cylindrical pile of debris that could only be the carcass of a gigantic ship. It was too distant for him to see any details, and it passed out of sight within a few seconds, but he could make out broken ribs and dully gleaming sheets of metal that had been partly peeled off like the skin of an orange. He wondered how many thousands of years the wreck had lain here on this deserted checkerboard - and what manner of creatures had sailed it between the stars.

Then he forgot the derelict, for something was coming up over the horizon.

At first it looked like a flat disk, but that was because it was heading almost directly toward him. As it approached and passed beneath, he saw that it was spindle-shaped, and several hundred feet long. Though there were faintly visible bands here and there along its length, it was hard to focus upon them; the object appeared to be vibrating, or perhaps spinning, at a very rapid rate.

It tapered to a point at either end, and there was no sign of propulsion. Only one thing about it was familiar to human eyes, and that was its color. If it was indeed a solid artifact, and not an optical phantom, then its makers perhaps shared some of the emotions of men.

But they certainly did not share their limitations, for the spindle appeared to be made of gold.

Bowman moved his head to the rear-view system to watch the thing drop behind. It had ignored him completely, and now he saw that it was falling out of the sky down toward one of those thousands of great slots. A few seconds later it disappeared in a final flash of gold as it dived into the planet. He was alone again, beneath that sinister sky, and the sense of isolation and remoteness was more overwhelming than ever.

Then he saw that he also was sinking down toward the mottled surface of the giant world, and that another of the rectangular chasms yawned immediately below. The empty sky closed above him, the clock crawled to rest, and once again his pod was falling between infinite ebon walls, toward another distant patch of stars. But now he was sure that he was not returning to the Solar System, and in a flash of insight that might have been wholly spurious, he knew what this thing must surely be.

It was some kind of cosmic switching device, routing the traffic of the stars through unimaginable dimensions of space and time. He was passing through a Grand Central Station of the galaxy.

42 - The Alien Sky

Far ahead, the walls of the slot were becoming dimly visible once more, in the faint light diffusing downward from some still hidden source. And then the darkness was abruptly whipped away, as the tiny space pod hurtled upward into a sky ablaze with stars.

He was back in space as he knew it, but a single glance told him that he was light-centuries from Earth.

He did not even attempt to find any of the familiar constellations that since the beginning of history had been the friends of man; perhaps none of the stars that now blazed around him had ever been seen by the unaided human eye.

Most of them were concentrated in a glowing belt, broken here and there with dark bands of obscuring cosmic dust, which completely circled the sky. It was like the Milky Way, but scores of times brighter; Bowman wondered if this was indeed his own galaxy, seen from a point much closer to its brilliant, crowded center.

He hoped that it was; then he would not be so far from home. But this, he realized at once, was a childish thought. He was so inconceivably remote from the Solar System that it made little difference whether he was in his own galaxy or the most distant one that any telescope had ever glimpsed.

He looked back to see the thing from which he was rising, and had another shock. Here was no giant, multifaceted world, nor any duplicate of Japetus. There was nothing - except an inky shadow against the stars, like

a doorway opening from a darkened room into a still darker night. Even as he watched, that doorway closed.

It did not recede from him; it slowly filled with stars, as if a rent in the fabric of space had been repaired. Then he was alone beneath the alien sky.

The space pod was slowly turning, and as it did so it brought fresh wonders into view. First there was a perfectly spherical swarm of stars, becoming more and more closely packed toward the center until its heart was a continuous glow of light. Its outer edges were ill-defined - a slowly thinning halo of suns that merged imperceptibly into the background of more distant stars.

This glorious apparition, Bowman knew, was a globular cluster. He was looking upon something that no human eye had ever seen, save as a smudge of light in the field of a telescope. He could not remember the distance to the nearest known cluster, but he was sure that there were none within a thousand light-years of the Solar System.

The pod continued its slow rotation, to disclose an even stranger sight - a huge red sun, many times larger than the Moon as seen from Earth. Bowman could look straight into its face without discomfort; judging by its color, it was no hotter than a glowing coal. Here and there, set into the somber red, were rivers of bright yellow - incandescent Amazons, meandering for thousands of miles before they lost themselves in the deserts of this dying sun.

Dying? No - that was a wholly false impression, born of human experience and the emotions aroused by the hues of sunset, or the glow of fading embers. This was a star that had left behind the fiery extravagances of its youth, had raced through the violets and blues and greens of the spectrum in a few fleeting billions of years, and now had settled down to a peaceful maturity of unimaginable length. All that had gone before was

not a thousandth of what was yet to come; the story of this star had barely begun.

The pod had ceased to roll; the great red sun lay straight ahead. Though there was no sense of motion, Bowman knew that he was still gripped by whatever controlling force had brought him here from Saturn.

All the science and engineering skill of Earth seemed hopelessly primitive now, against the powers that were carrying him to some unimaginable fate.

He stared into the sky ahead, trying to pick out the goal toward which he was being taken - perhaps some planet circling this great sun. But there was nothing that showed any visible disk or exceptional brightness; if there were planets orbiting here he could not distinguish them from the stellar background.

Then he noticed that something strange was happening on the very edge of the sun's crimson disk. A white glow had appeared there, and was rapidly waxing in brilliance; he wondered if he was seeing one of those sudden eruptions, or flares, that trouble most stars from time to time.

The light became brighter and bluer; it began to spread along the edge of the sun, whose blood-red hues paled swiftly by comparison. It was almost, Bowman told himself, smiling at the absurdity of the thought, as if he were watching sunrise - on a sun.

And so indeed he was. Above the burning horizon lifted something no larger than a star, but so brilliant that the eye could not bear to look upon it. A mere point of blue-white radiance, like an electric arc, was moving at unbelievable speed across the face of the great sun. It must be very close to its giant companion; for immediately below it, drawn upward by its gravitational pull, was a column of flame thousands of miles high. It was as if a tidal wave of fire was marching forever along the equator of this star, in vain pursuit of the searing apparition in its sky.

That pinpoint of incandescence must be a White Dwarf - one of those strange, fierce little stars, no larger than the Earth, yet containing a million times its mass. Such ill-matched stellar couples were not uncommon; but Bowman had never dreamed that one day he would see such a pair with his own eyes.

The White Dwarf had transited almost half the disk of its companion - it must take only minutes to make a complete orbit - when Bowman was at last certain that he too was moving. Ahead of him, one of the stars was becoming rapidly brighter, and was beginning to drift against its background. It must be some small, close body - perhaps the world toward which he was traveling.

It was upon him with unexpected speed; and he saw that it was not a world at all.

A dully gleaming cobweb or latticework of metal, hundreds of miles in extent, grew out of nowhere until it filled the sky. Scattered across its continent-wide surface were structures that must have been as large as cities, but which appeared to be machines. Around many of these were assembled scores of smaller objects, ranged in neat rows and columns. Bowman had passed several such groups before he realized that they were fleets of spaceships; he was flying over a gigantic orbital parking lot.

Because there were no familiar objects by which he could judge the scale of the scene flashing by below, it was almost impossible to estimate the size of the vessels hanging there in space. But they were certainly enormous; some must have been miles in length. They were of many different designs - spheres, faceted crystals, slim pencils, ovoids, disks. This must be one of the meeting places for the commerce of the stars.

Or it had been - perhaps a million years ago. For nowhere could Bowman see any sign of activity; this sprawling spaceport was as dead as the Moon.

He knew it not only by the absence of all movement, but by such unmistakable signs as great gaps torn in the metal cobweb by the wasplike blunderings of asteroids that must have smashed through it, eons ago. This was no longer a parking lot: it was a cosmic junk heap.

He had missed its builders by ages, and with that realization Bowman felt a sudden sinking of his heart. Though he had not known what to expect, at least he had hoped to meet some intelligence from the stars.

Now, it seemed, he was too late. He had been caught in an ancient, automatic trap, set for some unknown purpose, and still operating when its makers had long since passed away. It had swept him across the galaxy, and dumped him (with how many others?) in this celestial Sargasso, doomed soon to die when his air was exhausted.

Well, it was unreasonable to expect more. Already he had seen wonders for which many men would have sacrificed their lives. He thought of his dead companions; he had no cause for complaint.

Then he saw that the derelict spaceport was still sliding past him with undiminished speed. He was sweeping over its outlying suburbs; its ragged edge went by, and no longer partially eclipsed the stars. In a few more minutes, it had fallen behind.

His fate did not lie here - but far ahead, in the huge, crimson sun toward which the space pod was now unmistakably falling.

43 - Inferno

Now there was only the red sun, filling the sky from side to side. He was so close that its surface was no longer frozen into immobility by sheer scale. There were luminous nodules moving to and fro, cyclones of ascending and descending gas, prominences slowly rocketing toward the heavens. Slowly? They must be rising at a million miles an hour for their movement to be visible to his eye.

He did not even attempt to grasp the scale of the inferno toward which he was descending. The immensities of Saturn and Jupiter had defeated him, during Discovery's fly-by in that solar system now unknown gigamiles away. But everything he saw here was a hundred times larger still; he could do nothing but accept the images that were flooding into his mind, without attempting to interpret them.

As that sea of fire expanded beneath him, Bowman should have known fear - but, curiously enough, he now felt only a mild apprehension. It was not that his mind was benumbed with wonders; logic told him that he must surely be under the protection of some controlling and almost omnipotent intelligence. He was now so close to the red sun that he would have been burned up in a moment if its radiation had not been held at bay by some invisible screen. And during his voyage he had been subjected to accelerations that should have crushed him instantly - yet he had felt nothing. If so much trouble had been taken to preserve him, there was still cause for hope.

The space pod was now moving along a shallow arc almost parallel to the surface of the star, but slowly descending toward it. And now, for the first time, Bowman became aware of sounds. There was a faint, continuous roar, broken from time to time by crackles like tearing paper,

or distant lightning. This could be only the feeblest echo of an unimaginable cacophony; the atmosphere surrounding him must be racked by concussions that could tear any material object to atoms. Yet he was protected from this shattering tumult as effectively as from the heat.

Though ridges of flame thousands of miles high were rising and slowly collapsing around him, he was completely insulated from all this violence. The energies of the star raved past him, as if they were in another universe; the pod moved sedately through their midst, un-buffed and unscorched.

Bowman's eyes, no longer hopelessly confused by the strangeness and grandeur of the scene, began to pick out details which must have been there before, but which he had not yet perceived. The surface of this star was no formless chaos; there was pattern here, as in everything that nature created.

He noticed first the little whirlpools of gas - probably no larger than Asia or Africa - that wandered over the surface of the star. Sometimes he could look directly down into one of them, to see darker, cooler regions far below. Curiously enough, there appeared to be no sunspots; perhaps they were a disease peculiar to the star that shone on Earth.

And there were occasional clouds, like wisps of smoke blown before a gale. Perhaps they were indeed smoke, for this sun was so cold that real fire could exist here. Chemical compounds could be born and could live for a few seconds before they were again ripped apart by the fiercer nuclear violence that surrounded them.

The horizon was growing brighter, its color changing from gloomy red to yellow to blue to blistering violet.

The White Dwarf was coming up over the horizon, dragging its tidal wave of star-stuff behind it.

Bowman shielded his eyes from the intolerable glare of the little sun, and focused on the troubled starscape which its gravitational field was sucking skyward. Once he had seen a waterspout moving across the face of the Caribbean; this tower of flame had almost the same shape. Only the scale was slightly different, for at its base, the column was probably wider than the planet Earth.

And then, immediately beneath him, Bowman noticed something which was surely new, since he could hardly have overlooked it if it had been there before. Moving across the ocean of glowing gas were myriads of bright beads; they shone with a pearly light which waxed and waned in a period of a few seconds. And they were all traveling in the same direction, like salmon moving upstream; sometimes they weaved back and forth so that their paths intertwined, but they never touched.

There were thousands of them, and the longer Bowman stared, the more convinced he became that their motion was purposeful. They were too far away for him to make out any details of their structure; that he could see them at all in this colossal panorama meant that they must be scores - perhaps hundreds - of miles across. If they were organized entities, they were leviathans indeed, built to match the scale of the world they inhabited.

Perhaps they were only clouds of plasma, given temporary stability by some odd combination of natural forces - like the short-lived spheres of ball-lightning that still puzzled terrestrial scientists. That was an easy, and perhaps soothing, explanation; but as Bowman looked down upon that star-wide streaming, he could not really believe it. Those glittering nodes of light knew where they were going; they were deliberately converging upon the pillar of fire raised by the White Dwarf as it orbited overhead.

Bowman stared once more at that ascending column, now marching along the horizon beneath the tiny, massive star that ruled it. Could it be pure imagination - or were there patches of brighter luminosity creeping

up that great geyser of gas, as if myriads of shining sparks had combined into whole continents of phosphorescence?

The idea was almost beyond fantasy, but perhaps he was watching nothing less than a migration from star to star, across a bridge of fire. Whether it was a movement of mindless, cosmic beasts driven across space by some lemming-like urge, or a vast concourse of intelligent entities, he would probably never know.

He was moving through a new order of creation, of which few men had ever dreamed. Beyond the realms of sea and land and air and space lay the realms of fire, which he alone had been privileged to glimpse. It was too much to expect that he would also understand.

44 - Reception

The pillar of fire was marching over the edge of the sun, like a storm passing beyond the horizon. The scurrying flecks of light no longer moved across the redly glowing starscape still thousands of miles below. Inside his space pod, protected from an environment that could annihilate him within a millisecond, David Bowman awaited whatever had been prepared.

The White Dwarf was sinking fast as it hurtled along its orbit; presently it touched the horizon, set it aflame, and disappeared. A false twilight fell upon the inferno beneath, and in the sudden change of illumination Bowman became aware that something was happening in the space around him.

The world of the red sun seemed to ripple, as if he were looking at it through running water. For a moment he wondered if this was some

refractive effect, perhaps caused by the passage of an unusually violent shock wave through the tortured atmosphere in which he was immersed.

The light was fading; it seemed that a second twilight was about to fall. Involuntarily, Bowman looked upward, then checked himself sheepishly, as he remembered that here the main source of light was not the sky, but the blazing world below.

It seemed as if walls of some material like smoked glass were thickening around him, cutting out the red glow and obscuring the view. It became darker and darker; the faint roar of the stellar hurricanes also faded out. The space pod was floating in silence, and in night.

A moment later, there was the softest of bumps as it settled on some hard surface, and came to rest.

To rest on what? Bowman asked himself incredulously. Then light returned; and incredulity gave way to a heart-sinking despair - for as he saw what lay around him, he knew that he must be mad.

He was prepared, he thought, for any wonder. The only thing he had never expected was the utterly commonplace.

The space pod was resting on the polished floor of an elegant, anonymous hotel suite that might have been in any large city on Earth. He was staring into a living room with a coffee table, a divan, a dozen chairs, a writing desk, various lamps, a half-filled bookcase with some magazines lying on it, and even a bowl of flowers. Van Gogh's *Bridge at Arles* was hanging on one wall - Wyeth's *Christina's World* on another. He felt confident that when he pulled open the drawer of that desk, he would find a Gideon Bible inside it...

If he was indeed mad, his delusions were beautifully organized. Everything was perfectly real; nothing vanished when he turned his back.

The only incongruous element in the scene - and that certainly a major one - was the space pod itself.

For many minutes, Bowman did not move from his seat. He half expected the vision around him to go away, but it remained as solid as anything he had ever seen in his life.

It was real - or else a phantom of the senses so superbly contrived that there was no way of distinguishing it from reality. Perhaps it was some kind of test; if so, not only his fate but that of the human race might well depend upon his actions in the next few minutes.

He could sit here and wait for something to happen, or he could open the pod and step outside to challenge the reality of the scene around him. The floor appeared to be solid; at least, it was bearing the weight of the space pod. He was not likely to fall through it - whatever "it" might really be.

But there was still the question of air; for all that he could tell, this room might be in vacuum, or might contain a poisonous atmosphere. He thought it very unlikely - no one would go to all this trouble without attending to such an essential detail - but he did not propose to take unnecessary risks. In any event, his years of training made him wary of contamination; he was reluctant to expose himself to an unknown environment until he knew that there was no alternative. This place looked like a hotel room somewhere in the United States. That did not alter the fact that in reality he must be hundreds of light-years from the Solar System.

He closed the helmet of his suit, sealing himself in, and actuated the hatch of the space pod. There was a brief hiss of pressure equalization; then he stepped out into the room.

As far as he could tell, he was in a perfectly normal gravity field. He raised one arm, then let it fall freely. It flopped to his side in less than a second.

This made everything seem doubly unreal. Here he was wearing a spacesuit, standing - when he should have been floating - outside a vehicle which could only function properly in the absence of gravity. All his normal astronaut's reflexes were upset; he had to think before he made every movement.

Like a man in a trance he walked slowly from his bare, unfurnished half of the room toward the hotel suite. It did not, as he had almost expected, disappear as he approached, but remained perfectly real - and apparently perfectly solid.

He stopped beside the coffee table. On it sat a conventional Bell System vision-phone, complete with the local directory. He bent down and picked up the volume with his clumsy, gloved hands.

It bore, in the familiar type he had seen thousands of times, the name: WASHINGTON, D.C.

Then he looked more closely; and for the first time, he had objective proof that, although all this might be real, he was not on Earth.

He could read only the word Washington; the rest of the printing was a blur, as if it had been copied from a newspaper photograph. He opened the book at random and riffled through the pages. They were all blank sheets of crisp white material which was certainly not paper, though it looked very much like it.

He lifted the telephone receiver and pressed it against the plastic of his helmet. If there had been a dialing sound he could have heard it through the conducting material. But, as he had expected, there was only silence.

So - it was all a fake, though a fantastically careful one. And it was clearly not intended to deceive but rather - he hoped - to reassure. That was a very comforting thought; nevertheless he would not remove his suit

until he had completed his voyage of exploration. All the furniture seemed sound and solid enough; he tried the chairs, and they supported his weight. But the drawers in the desk would not open; they were dummies.

So were the books and magazines; like the telephone directory, only the titles were readable. They formed an odd selection - mostly rather trashy best sellers, a few sensational works of nonfiction, and some well-publicized autobiographies. There was nothing less than three years old, and little of any intellectual content. Not that it mattered, for the books could not even be taken down from the shelves.

There were two doors that opened readily enough. The first one took him into a small but comfortable bedroom, fitted with a bed, bureau, two chairs, light switches that actually worked, and a clothes closet. He opened this, and found himself looking at four suits, a dressing gown, a dozen white shirts, and several sets of underwear, all neatly draped from hangers.

He took down one of the suits, and inspected it carefully. As far as his gloved hands could judge, it was made of material that was more like fur than wool. It was also a little out of style; on Earth, no one had been wearing single-breasted suits for at least four years.

Next to the bedroom was a bathroom, complete with fittings which, he was relieved to note, were not dummies, but worked in a perfectly normal manner. And after that was a kitchenette, with electric cooker, refrigerator, storage cupboards, crockery and cutlery, sink, table, and chairs. Bowman began to explore this not only with curiosity, but with mounting hunger.

First he opened the refrigerator, and a wave of cold mist rolled out. The shelves were well stocked with packages and cans, all of them looking perfectly familiar from a distance, though at close quarters their proprietary labels were blurred and unreadable. However, there was a notable absence of eggs, milk, butter, meat, fruit, or any other unprocessed food; the refrigerator held only items that had already been packaged in some way.

Bowman picked up a carton of a familiar breakfast cereal, thinking as he did so that it was odd to keep this frozen. The moment he lifted the package, he knew that it certainly did not contain cornflakes; it was much too heavy.

He ripped open the lid, and examined the contents.

The box contained a slightly moist blue substance, of about the weight and texture of bread pudding. Apart from its odd color, it looked quite appetizing.

But this is ridiculous, Bowman told himself. I am almost certainly being watched, and I must look an idiot wearing this suit. If this is some kind of intelligence test, I've probably failed already. Without further hesitation, he walked back into the bedroom and began to undo the clamp of his helmet. When it was loose, he lifted the helmet a fraction of an inch, cracked the seal and took a cautious sniff. As far as he could tell, he was breathing perfectly normal air.

He dropped the helmet on the bed, and began thankfully - and rather stiffly - to divest himself of his suit. When he had finished, he stretched, took a few deep breaths, and carefully hung the spacesuit up among the more conventional articles of clothing in the closet. It looked rather odd there, but the compulsive tidiness that Bowman shared with all astronauts would never have allowed him to leave it anywhere else.

Then he walked quickly back into the kitchen and began to inspect the "cereal" box at closer quarters.

The blue bread pudding had a faint, spicy smell, something like a macaroon. Bowman weighed it in his hand, then broke off a piece and cautiously sniffed at it. Though he felt sure now that there would be no deliberate attempt to poison him, there was always the possibility of mistakes - especially in a matter so complex as biochemistry.

He nibbled at a few crumbs, then chewed and swallowed the fragment of food; it was excellent, though the flavor was so elusive as to be almost indescribable. If he closed his eyes, he could imagine it was meat, or wholemeal bread, or even dried fruit. Unless there were unexpected aftereffects, he had no cause to fear starvation.

When he had eaten just a few mouthfuls of the substance, and already felt quite satisfied, he looked for something to drink. There were half a dozen cans of beer - again of a famous brand - at the back of the refrigerator, and he pressed the tab on one of them to open it.

The prestressed metal lid popped off along its strain lines, exactly as usual. But the can did not contain beer; to Bowman's surprised disappointment, it held more of the blue food.

In a few seconds he had opened half a dozen of the other packages and cans. Whatever their labels, their contents were the same; it seemed that his diet was going to be a little monotonous, and that he would have nothing but water to drink. He filled a glass from the kitchen faucet and sipped at it cautiously.

He spat out the first few drops at once; the taste was terrible. Then, rather ashamed of his instinctive reaction, he forced himself to drink the rest.

That first sip had been enough to identify the liquid. It tasted terrible because it had no taste at all; the faucet was supplying pure, distilled water. His unknown hosts were obviously taking no chances with his health.

Feeling much refreshed, he then had a quick shower. There was no soap, which was another minor inconvenience, but there was a very efficient hot-air drier in which he luxuriated for a while before trying on underpants, vest, and dressing gown from the clothes closet. After that, he

lay down on the bed, stared up at the ceiling, and tried to make sense of this fantastic situation.

He had made little progress when he was distracted by another line of thought. Immediately above the bed was the usual hotel-type ceiling TV screen; he had assumed that, like the telephone and books, it was a dummy.

But the control unit on its swinging bedside arm looked so realistic that he could not resist playing with it; and as his fingers touched the ON sensor disk, the screen lit up.

Feverishly, he started to tap out channel selector codes at random - and almost at once he got his first picture.

It was a well-known African news commentator, discussing the attempts being made to preserve the last remnants of his country's wild life. Bowman listened for a few seconds, so captivated by the sound of a human voice that he did not in the least care what it was talking about. Then he changed channels.

In the next five minutes, he got a symphony orchestra playing Walton's Violin Concerto, a discussion on the sad state of the legitimate theater, a western, a demonstration of a new headache cure, a panel game in some Oriental language, a psychodrama, three news commentaries, a football game, a lecture on solid geometry (in Russian), and several tuning signals and data transmissions. It was, in fact, a perfectly normal selection from the world's TV programs, and apart from the psychological uplift it gave him, it confirmed one suspicion that had already been forming in his mind.

All the programs were about two years old. That was around the time TMA-1 had been discovered, and it was hard to believe that this was a pure coincidence. Something had been monitoring the radio waves; that ebon block had been busier than men had suspected.

He continued to wander across the spectrum, and suddenly recognized a familiar scene. Here was this very suite, now occupied by a celebrated actor who was furiously denouncing an unfaithful mistress. Bowman looked with a shock of recognition upon the living room he had just left - and when the camera followed the indignant couple toward the bedroom, he involuntarily looked toward the door to see if anyone was entering.

So that was how this reception area had been prepared for him; his hosts had based their ideas of terrestrial living upon TV programs. His feeling that he was inside a movie set was almost literally true.

He had learned all that he wished to for the moment, and turned off the set. What do I do now? he asked himself, locking his fingers behind his head and staring up at the blank screen.

He was physically and emotionally exhausted, yet it seemed impossible that one could sleep in such fantastic surroundings, and farther from Earth than any man in history had ever been. But the comfortable bed, and the instinctive wisdom of the body, conspired together against his will.

He fumbled for the light switch, and the room was plunged into darkness. Within seconds, he had passed beyond the reach of dreams.

So, for the last time, David Bowman slept.

45 - Recapitulation

There being no further use for it, the furniture of the suite dissolved back into the mind of its creator. Only the bed remained - and the walls, shielding this fragile organism from the energies it could not yet control.

In his sleep, David Bowman stirred restlessly. He did not wake, nor did he dream, but he was no longer wholly unconscious. Like a fog creeping through a forest, something invaded his mind. He sensed it only dimly, for the full impact would have destroyed him as surely as the fires raging beyond these walls. Beneath that dispassionate scrutiny, he felt neither hope nor fear; all emotion had been leached away.

He seemed to be floating in free space, while around him stretched, in all directions, an infinite geometrical grid of dark lines or threads, along which moved tiny nodes of light - some slowly, some at dazzling speed.

Once he had peered through a microscope at a cross-section of a human brain, and in its network of nerve fibers had glimpsed the same labyrinthine complexity. But that had been dead and static, whereas this transcended life itself. He knew - or believed he knew - that he was watching the operation of some gigantic mind, contemplating the universe of which he was so tiny a part.

The vision, or illusion, lasted only a moment. Then the crystalline planes and lattices, and the interlocking perspectives of moving light, flickered out of existence, as David Bowman moved into a realm of consciousness that no man had experienced before.

At first, it seemed that Time itself was running backward. Even this marvel he was prepared to accept, before he realized the subtler truth.

The springs of memory were being tapped; in controlled recollection, he was reliving the past. There was the hotel suite - there the space pod - there the burning starscapes of the red sun - there the shining core of the galaxy - there the gateway through which he had reemerged into the universe. And not only vision, but all the sense impressions, and all the emotions he had felt at the time, were racing past, more and more swiftly. His life was unreeling like a tape recorder playing back at ever-increasing speed.

Now he was once more aboard the Discovery and the rings of Saturn filled the sky. Before that, he was repeating his final dialogue with Hal; he was seeing Frank Poole leave on his last mission; he was hearing the voice of Earth, assuring him that all was well.

And even as he relived these events, he knew that all indeed was well. He was retrogressing down the corridors of time, being drained of knowledge and experience as he swept back toward his childhood. But nothing was being lost; all that he had ever been, at every moment of his life, was being transferred to safer keeping. Even as one David Bowman ceased to exist, another became immortal.

Faster, faster he moved back into forgotten years, and into a simpler world. Faces he had once loved, and had thought lost beyond recall, smiled at him sweetly. He smiled back with fondness, and without pain.

Now, at last, the headlong regression was slackening; the wells of memory were nearly dry. Time flowed more and more sluggishly, approaching a moment of stasis - as a swinging pendulum, at the limit of its arc, seems frozen for one eternal instant, before the next cycle begins.

The timeless instant passed; the pendulum reversed its swing. In an empty room, floating amid the fires of a double star twenty thousand light-years from Earth, a baby opened its eyes and began to cry.

46 - Transformation

Then it became silent, as it saw that it was no longer alone.

A ghostly, glimmering rectangle had formed in the empty air. It solidified into a crystal tablet, lost its transparency, and became suffused

with a pale, milky luminescence. Tantalizing, ill-defined phantoms moved across its surface and in its depths. They coalesced into bars of lights and shadow, then formed intermeshing, spoked patterns that began slowly to rotate, in time with the pulsing rhythm that now seemed to fill the whole of space.

It was a spectacle to grasp and hold the attention of any child - or of any man-ape. But, as it had been three million years before, it was only the outward manifestation of forces too subtle to be consciously perceived. It was merely a toy to distract the senses, while the real processing was carried out at far deeper levels of the mind.

This time, the processing was swift and certain, as the new design was woven. For in the eons since their last meeting, much had been learned by the weaver; and the material on which he practiced his art was now of an infinitely finer texture. But whether it should be permitted to form part of his still-growing tapestry, only the future could tell.

With eyes that already held more than human intentness, the baby stared into the depths of the crystal monolith, seeing - but not yet understanding - the mysteries that lay beyond. It knew that it had come home, that here was the origin of many races besides its own; but it knew also that it could not stay. Beyond this moment lay another birth, stranger than any in the past.

Now the moment had come; the glowing patterns no longer echoed the secrets in the crystal's heart. As they died, so too the protective walls faded back into the nonexistence from which they had briefly emerged, and the red sun filled the sky.

The metal and plastic of the forgotten space pod, and the clothing once worn by an entity who had called himself David Bowman, flashed into flame. The last links with Earth were gone, resolved back into their component atoms.

But the child scarcely noticed, as he adjusted himself to the comfortable glow of his new environment. He still needed, for a little while, this shell of matter as the focus of his powers. His indestructible body was his mind's present image of itself; and for all his powers, he knew that he was still a baby. So he would remain until he had decided on a new form, or had passed beyond the necessities of matter.

And now it was time to go - though in one sense he would never leave this place where he had been reborn, for he would always be part of the entity that used this double star for its unfathomable purposes. The direction, though not the nature, of his destiny was clear before him, and there was no need to trace the devious path by which he had come. With the instincts of three million years, he now perceived that there were more ways than one behind the back of space. The ancient mechanisms of the Star Gate had served him well, but he would not need them again.

The glimmering rectangular shape that had once seemed no more than a slab of crystal still floated before him, indifferent as he was to the harmless flames of the inferno beneath. It encapsulated yet unfathomed secrets of space and time, but some at least he now understood and was able to command. How obvious - how necessary - was that mathematical ratio of its sides, the quadratic sequence $1 : 4 : 9!$ And how naive to have imagined that the series ended at this point, in only three dimensions!

He focused his mind upon these geometrical simplicities, and as his thoughts brushed against it, the empty framework filled with the darkness of the interstellar night. The glow of the red sun faded - or, rather, seemed to recede in all directions at once - and there before him was the luminous whirlpool of the galaxy.

It might have been some beautiful, incredibly detailed model, embedded in a block of plastic. But it was the reality, grasped as a whole with senses now more subtle than vision. If he wished, he could focus his attention upon any one of its hundred billion stars; and he could do much more than that.

Here he was, adrift in this great river of suns, halfway between the banked fires of the galactic core and the lonely, scattered sentinel stars of the rim. And here he wished to be, on the far side of this chasm in the sky, this serpentine band of darkness, empty of all stars. He knew that this formless chaos, visible only by the glow that limned its edges from fire-mists far beyond, was the still unused stuff of creation, the raw material of evolutions yet to be. Here, Time had not begun; not until the suns that now burned were long since dead would light and life reshape this void.

Unwittingly, he had crossed it once; now he must cross it again - this time, of his own volition. The thought filled him with a sudden, freezing terror, so that for a moment he was wholly disorientated, and his new vision of the universe trembled and threatened to shatter into a thousand fragments.

It was not fear of the galactic gulfs that chilled his soul, but a more profound disquiet, stemming from the unborn future. For he had left behind the time scales of his human origin; now, as he contemplated that band of starless night, he knew his first intimations of the Eternity that yawned before him.

Then he remembered that he would never be alone, and his panic slowly ebbed. The crystal-clear perception of the universe was restored to him - not, he knew, wholly by his own efforts. When he needed guidance in his first faltering steps, it would be there.

Confident once more, like a high diver who had regained his nerve, he launched himself across the light-years. The galaxy burst forth from the mental frame in which he had enclosed it; stars and nebulae poured past him in an illusion of infinite speed. Phantom suns exploded and fell behind as he slipped like a shadow through their cores; the cold, dark waste of cosmic dust which he had once feared seemed no more than the beat of a raven's wing across the face of the Sun.

The stars were thinning out; the glare of the Milky Way was dimming into a pale ghost of the glory he had known - and, when he was ready, would know again.

He was back, precisely where he wished to be, in the space that men called real.

47 - Star-Child

There before him, a glittering toy no Star-Child could resist, floated the planet Earth with all its peoples.

He had returned in time. Down there on that crowded globe, the alarms would be flashing across the radar screens, the great tracking telescopes would be searching the skies - and history as men knew it would be drawing to a close.

A thousand miles below, he became aware that a slumbering cargo of death had awoken, and was stirring sluggishly in its orbit. The feeble energies it contained were no possible menace to him; but he preferred a cleaner sky. He put forth his will, and the circling megatons flowered in a silent detonation that brought a brief, false dawn to half the sleeping globe. Then he waited, marshaling his thoughts and brooding over his still untested powers. For though he was master of the world, he was not quite sure what to do next.

But he would think of something.

Epilogue: After 2001

The novel 2001: A Space Odyssey was written during the years 1964-1968 and was published in July 1968, shortly after release of the movie. As I have described in The Lost Worlds of 2001, both projects proceeded simultaneously, with feedback in each direction.

Thus I often had the strange experience of revising the manuscript after viewing rushes based upon an earlier version of the story - a stimulating but rather expensive way of writing a novel.

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Richard Strauss' Zarathustra theme, now universally identified with the movie. Immediately after the loss of power, Jack Swigert radioed back to Mission Control: "Houston, we've had a problem." The words that Hal used to Frank Poole on a similar occasion were: "Sorry to interrupt the festivities, but we have a problem."

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Almost a decade later, the crew of the superbly successful Skylab realized that its designers had provided them with a similar geometry; a ring of storage cabinets formed a smooth, circular band around the space station's interior. Skylab, however, was not spinning, but this did not deter its ingenious occupants. They discovered that they could run around the track, just like mice in a squirrel cage, to produce a result visually indistinguishable from that shown in 2001. And they televised the whole exercise back to Earth (need I name the accompanying music?) with the comment: "Stanley Kubrick should see this." As in due course he did, because I sent him the telecine recording. (I never got it back; Stanley uses a tame Black Hole as a filing system.)

There is also the strange case of the "Eye of Japetus," described in Chapter 35, where Bowman discovers "a brilliant white oval... so sharp-edged that it almost looked... painted on the face of the little moon" with a tiny black dot at the exact center, which turns out to be the Monolith (or one of its avatars).

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When, fourteen years ago, I typed the final words "For though he was master of the world, he was not quite sure what to do next. But he would think of something" I felt I had closed the circuit and precluded all possibility of a sequel. Indeed, for the next decade I ridiculed the very idea, for what seemed to me conclusive reasons. Since 2001 was concerned with the next stage of human evolution, to expect me (or even Stanley) to depict it would be as absurd as asking Moon-watcher to describe Bowman and his world.

Despite my protests, it is now obvious that my busy little subconscious was hard at work, perhaps in response to the constant stream of letters from readers wanting to know "what happened next." Finally, as an intellectual exercise, I wrote a précis of a possible sequel in the form of a short movie outline and sent copies to Stanley Kubrick and my agent, Scott Meredith. As far as Stanley was concerned, this was an act of courtesy, for I knew that he never repeats himself (just as I never write sequels), but I hoped that Scott would sell the outline to Omni magazine, which had recently published another outline, "The Songs of Distant Earth." Then, I fondly hoped, the ghost of 2001 would be finally exorcised.

Stanley expressed guarded interest, but Scott was enthusiastic - and implacable. "You've simply got to write the book," he said. With a groan, I realized that he was right...

So now, gentle reader (to coin a phrase), you can find what happens next in 2010: Space Odyssey Two. I am extremely grateful to New

American Library, copyright holders of 2001: A Space Odyssey, for permission to use Chapter 37 in the new novel; It serves as a link, connecting the two books together.

A final comment on both novels as seen from a point now almost exactly midway between the year 2001 and the time when Stanley Kubrick and I started working together. Contrary to popular belief, science fiction writers very seldom attempt to predict the future; indeed, as Ray Bradbury put it so well, they more often try to prevent it. In 1964, the first heroic period of the Space Age was just opening; the United States had set the Moon as its target, and once that decision had been made, the ultimate conquest of the other planets, appeared inevitable. By 2001, it seemed quite reasonable that there would be giant space-stations in orbit round the Earth and - a little later - manned expeditions to the planets.

In an ideal world, that would have been possible: the Vietnam War would have paid for everything that Stanley Kubrick showed on the Cinerama screen. Now we realize that it will take a little longer.

2001 will not arrive by 2001. Yet - barring accidents - by that date almost everything depicted in the book and the movie will be in the advanced planning stage.

Except for communication with alien intelligences: that is something that can never be planned - only anticipated. No one knows whether it will happen tomorrow - or a thousand years hence.

But it will happen someday.

ARTHUR C. CLARKE

Colombo, Sri Lanka

November, 1982

Ballantine/30326 (Canada \$8.95) U.S. \$5.95

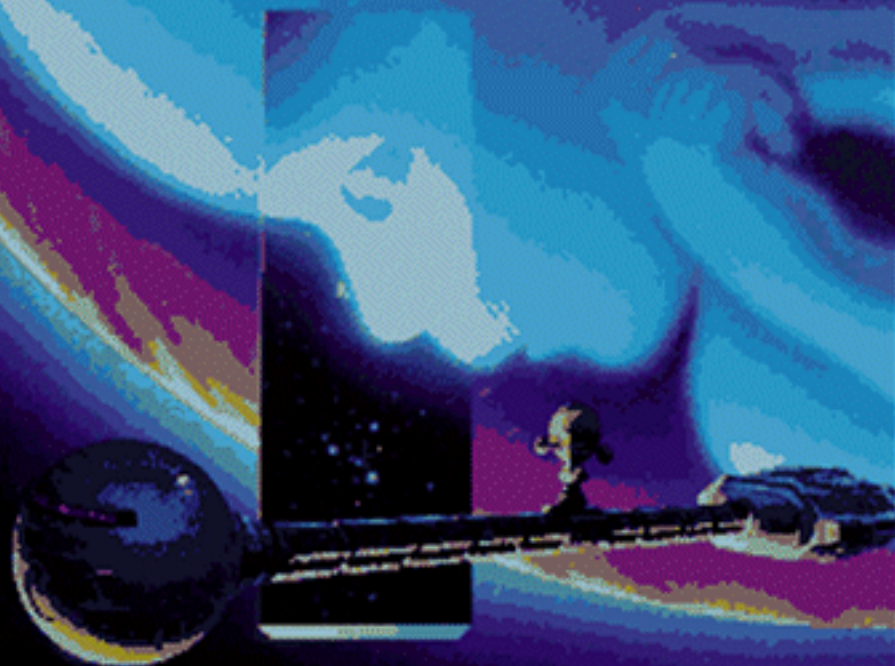


Arthur C. Clarke

2010: odyssey two

"A daring romp through the solar system
and a worthy successor to 2001."

Carl Sagan



2010:

Odyssey Two

Arthur C. Clarke

Title: 2010: Odyssey two
Author: Arthur C. Clarke
Original copyright year: 1982

Dedicated, with respectful admiration, to two great Russians, both depicted herein:

**General Alexei Leonov
Cosmonaut, Hero of the Soviet Union, Artist**

and

**Academician Andrei Sakharov
Scientist, Nobel Laureate, Humanist.**

Author's Note

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Yet, all things considered, both movie and book stand up quite well in the light of these discoveries, and it is fascinating to compare the Jupiter sequences in the film with the actual movies from the Voyager cameras. But clearly, anything written today has to incorporate the results of the 1979 explorations: the moons of Jupiter are no longer uncharted territory.

And there is another, more subtle, psychological factor to be taken into consideration. 2001 was written in an age that now lies beyond one of the Great Divides in human history; we are sundered from it forever by the moment when Neil Armstrong set foot upon the Moon. The date 20 July 1969 was still half a decade in the future when Stanley Kubrick and I started thinking about the 'proverbial good science-fiction movie' (his phrase). Now history and fiction have become inextricably intertwined.

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'Stanley Kubrick should see this.' As in due course he did, because I sent him the telecine recording. (I never got it back; Stanley uses a tame Black Hole as a filing system.)

Yet another link between film and reality is the painting by Apollo-Soyuz Commander, Cosmonaut Alexei Leonov, 'Near the Moon'. I first saw it in 1968, when 2001 was presented at the United Nations Conference on the Peaceful Uses of Outer Space. Immediately after the screening, Alexei pointed out to me that his concept (on page 32 of the Leonov-Sokolov book *The Stars Are Awaiting Us*, Moscow, 1967) shows exactly the same line-up as the movie's opening: the Earth rising beyond

the Moon, and the Sun rising beyond them both. His autographed sketch of the painting now hangs on my office wall; for further details see Chapter 12.

Perhaps this is the appropriate point to identify another and less well-known name appearing in these pages, that of Hsue-shen Tsien. In 1936, with the great Theodore von Karman and Frank J. Malina, Dr Tsien founded the Guggenheim Aeronautical Laboratory of the California Institute of Technology (GALCIT) - the direct ancestor of Pasadena's famed Jet Propulsion Laboratory. He was also the first Goddard Professor at Caltech, and contributed greatly to American rocket research through the 1940s. Later, in one of the most disgraceful episodes of the McCarthy period, he was arrested on trumped-up security charges when he wished to return to his native country. For the last two decades, he has been one of the leaders of the Chinese rocket programme.

Finally, there is the strange case of the 'Eye of Japetus' - Chapter 35 of 2001. Here I describe astronaut Bowman's discovery on the Saturnian moon of a curious feather 'a brilliant white oval, about four hundred miles long and two hundred wide... perfectly symmetrical... and so sharp-edged that it almost looked... painted on the face of the little moon.' As he came closer, Bowman convinced himself that 'the bright ellipse set against the dark background of the satellite was a huge empty eye staring at him as he approached...' Later, he noticed 'the tiny black dot at the exact centre', which turns out to be the Monolith (or one of its avatars).

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Inevitably, therefore, the story you are about to read is something much more complex than a straightforward sequel to the earlier novel - or the

movie. Where these differ, I have followed the screen version; however, I have been more concerned with making this book self-consistent, and as accurate as possible in the light of current knowledge.

Which, of course, will once more be out of date by 2001...

Arthur C. Clarke
COLOMBO, SRI LANKA
JANUARY 1982

I

LEONOV

Meeting at the Focus

Even in this metric age, it was still the thousand-foot telescope, not the three-hundred-metre one. The great saucer set among the mountains was already half full of shadow, as the tropical sun dropped swiftly to rest, but the triangular raft of the antenna complex suspended high above its centre still blazed with light. From the ground far below, it would have taken keen eyes to notice the two human figures in the aerial maze of girders, support cables, and wave-guides.

'The time has come,' said Dr Dimitri Moisevitch to his old friend Heywood Floyd, 'to talk of many things. Of shoes and spaceships and sealing wax, but mostly of monoliths and malfunctioning computers.'

'So that's why you got me away from the conference. Not that I really mind - I've heard Carl give that SETI speech so many times that I can recite it myself. And the view certainly is fantastic - you know, all the times I've been to Arecibo, I've never made it up here to the antenna feed.'

'Shame on you. I've been here three times. Imagine - we're listening to the whole universe - but no one can overhear us. So let's talk about your problem.'

'What problem?'

'To start with, why you had to resign as Chairman of the National Council on Astronautics.'

'I didn't resign. The University of Hawaii pays a lot better.'

'Okay - you didn't resign - you were one jump ahead of them. After all these years, Woody, you can't fool me, and you should give up trying. If they offered the NCA back to you right now, would you hesitate?'

'All right, you old Cossak. What do you want to know?'

'First of all, there are lots of loose ends in the report you finally issued after so much prodding. We'll overlook the ridiculous and frankly illegal secrecy with which your people dug up the Tycho monolith -'

'That wasn't my idea.'

'Glad to hear it: I even believe you. And we appreciate the fact that you're now letting everyone examine the thing - which of course is what you should have done in the first place. Not that it's done much good...'

There was a gloomy silence while the two men contemplated the black enigma up there on the Moon, still contemptuously defying all the weapons that human ingenuity could bring to bear upon it. Then the Russian scientist continued.

'Anyway, whatever the Tycho monolith may be, there's something more important out at Jupiter. That's where it sent its signal, after all. And that's where your people ran into trouble. Sorry about that, by the way - though Frank Poole was the only one I knew personally. Met him at the '98 IAF Congress - he seemed a good man.'

'Thank you; they were all good men. I wish we knew what happened to them.'

'Whatever it was, surely you'll admit that it now concerns the whole human race - not merely the United States. You can no longer try to use your knowledge for purely national advantage.'

'Dimitri - you know perfectly well that your side would have done exactly the same thing. And you'd have helped.'

'You're absolutely right. But that's ancient history - like the just-departed administration of yours that was responsible for the whole mess. With a new President, perhaps wiser counsels will prevail.'

'Possibly. Do you have any suggestions, and are they official or just personal hopes?'

'Entirely unofficial at the moment. What the bloody politicians call exploratory talks. Which I shall flatly deny ever occurred.'

'Fair enough. Go on.'

'Okay - here's the situation. You're assembling Discovery 2 in parking orbit as quickly as you can, but you can't hope to have it ready in less than three years, which means you'll miss the next launch window -,

'I neither confirm nor deny. Remember I'm merely a humble university chancellor, the other side of the world from the Astronautics Council.'

'And your last trip to Washington was just a holiday to see old friends, I suppose. To continue: our own Alexei Leonov -,

'I thought you were calling it Gherman Titov.'

'Wrong, Chancellor. The dear old CIA's let you down again. Leonov it is, as of last January. And don't let anyone know I told you it will reach Jupiter at least a year ahead of Discovery.'

'Don't let anyone know I told you we were afraid of that. But do go on.'

'Because my bosses are just as stupid and shortsighted as yours, they want to go it alone. Which means that whatever went wrong with you may happen to us, and we'll all be back to square one - or worse.'

'What do you think went wrong? We're just as baffled as you are. And don't tell me you haven't got all of Dave Bowman's transmissions.'

'Of course we have. Right up to that last "My God, it's full of stars!" We've even done a stress analysis on his voice patterns. We don't think he was hallucinating; he was trying to describe what he actually saw.'

'And what do you make of his doppler shift?'

'Completely impossible, of course. When we lost his signal, he was receding at a tenth of the speed of light. And he'd reached that in less than two minutes. A quarter of a million gravities!'

'So he must have been killed instantly.'

'Don't pretend to be naive, Woody. Your space-pod radios aren't built to withstand even a hundredth of that acceleration. If they could survive, so could Bowman - at least, until we lost contact.'

'Just doing an independent check on your deductions. From there on, we're as much in the dark as you are. If you are.'

'Merely playing with lots of crazy guesses I'd be ashamed to tell you. Yet none of them, I suspect, will be half as crazy as the truth.'

In small crimson explosions the navigation warning lights winked on all around them, and the three slim towers supporting the antenna complex began to blaze like beacons against the darkling sky. The last red sliver of the sun vanished below the surrounding hills; Heywood Floyd waited for the Green Flash, which he had never seen. Once again, he was disappointed.

'So, Dimitri,' he said, 'let's get to the point. Just what are you driving at?'

'There must be a vast amount of priceless information stored in Discovery's data banks; presumably it's still being gathered, even though the ship's stopped transmitting. We'd like to have that.'

'Fair enough. But when you get out there, and Leonov makes a rendezvous, what's to prevent you from boarding Discovery and copying everything you want?'

'I never thought I'd have to remind you that Discovery is United States territory, and an unauthorized entry would be piracy.'

'Except in the event of a life-or-death emergency, which wouldn't be difficult to arrange. After all, it would be hard for us to check what your boys were up to, from a billion kilometres away.'

'Thanks for the most interesting suggestion; I'll pass it on. But even if we went aboard, it would take us weeks to learn all your systems, and read out all your memory banks. What I propose is cooperation. I'm convinced that's the best idea - but we may both have a job selling it to our respective bosses.'

'You want one of our astronauts to fly with Leonov?'

'Yes - preferably an engineer who's specialized in Discovery's systems. Like the ones you're training at Houston to bring the ship home.'

'How did you know that?'

'For heaven's sake, Woody - it was on Aviation Week's videotext at least a month ago.'

'I am out of touch; nobody tells me what's been declassified.'

'All the more reason to spend time in Washington. Will you back me up?'

'Absolutely. I agree with you one hundred per cent. But -'

'But what?'

'We both have to deal with dinosaurs with brains in their tails. Some of mine will argue: Let the Russians risk their necks, hurrying out to Jupiter. We'll be there anyway a couple of years later - and what's the hurry?'

For a moment there was silence on the antenna raft, except for a faint creak from the immense supporting cables that held it suspended a hundred metres in the sky. Then Moisevitch continued, so quietly that Floyd had to strain to hear him: 'Has anyone checked Discovery's orbit lately?'

'I really don't know - but I suppose so. Anyway, why bother? It's a perfectly stable one.'

'Indeed. Let me tactlessly remind you of an embarrassing incident from the old NASA days. Your first space station - Skylab. It was supposed to stay up at least a decade, but you didn't do your calculations right. The air drag in the ionosphere was badly underestimated, and it came down years ahead of schedule. I'm sure you remember that little cliffhanger, even though you were a boy at the time.'

'It was the year I graduated, and you know it. But Discovery doesn't go anywhere near Jupiter. Even at perigee - er, perijove - it's much too high to be affected by atmospheric drag.'

'I've already said enough to get me exiled to my dacha again - and you might not be allowed to visit me next time. So just ask your tracking

people to do their job more carefully, will you? And remind them that Jupiter has the biggest magnetosphere in the Solar System.'

'I understand what you're driving at - many thanks. Anything else before we go down? I'm starting to freeze.'

'Don't worry, old friend. As soon as you let all this filter through to Washington - wait a week or so until I'm clear -things are going to get very, very hot.'

2

The House of the Dolphins

The dolphins swam into the dining room every evening, just before sunset. Only once since Floyd had occupied the Chancellor's residence had they broken their routine. That was the day of the '05 tsunami, which, fortunately, had lost most of its power before it reached Hilo. The next time his friends failed to turn up on schedule, Floyd would throw the family into the car and head for high ground, in the general direction of Mauna Kea.

Charming though they were, he had to admit that their playfulness was sometimes a nuisance. The wealthy marine geologist who had designed the house had never minded getting wet because he usually wore bathing trunks - or less. But there had been one unforgettable occasion when the entire Board of Regents, in full evening attire, had been sipping cocktails around the pool while awaiting the arrival of a distinguished guest from the mainland. The dolphins had deduced, correctly, that they would get second billing. So the visitor was quite surprised to be greeted by a

bedraggled committee in ill-fitting bathrobes - and the buffet had been very salty.

Floyd often wondered what Marion would have thought of his strange and beautiful home on the edge of the Pacific. She had never liked the sea, but the sea had won in the end. Though the image was slowly fading, he could still recall the flashing screen on which he had first read the words: DR FLOYD - URGENT AND PERSONAL. And then the scrolling lines of fluorescent print that had swiftly burned their message into his mind:

REGRET TO INFORM YOU LONDON-WASHINGTON FLIGHT
452 REPORTED DOWN OFF NEWFOUNDLAND. RESCUE CRAFT
PROCEEDING TO LOCATION BUT FEAR NO SURVIVORS.

Apart from an accident of fate, he would have been on that flight. For a few days, he had almost regretted the European Space Administration business that had delayed him in Paris; that haggle over the Solaris payload had saved his life.

And now, he had a new job, a new home and a new wife. Fate had also played an ironic role here. The recriminations and inquiries over the Jupiter mission had destroyed his Washington career, but a man of his ability was never unemployed for long. The more leisurely tempo of university life had always appealed to him, and when combined with one of the world's most beautiful locations it had proved irresistible. He had met the woman who was to be his second wife only a month after he had been appointed, while watching the fire fountains of Kilauea with a crowd of tourists.

With Caroline he had found the contentment that is just as important as happiness, and longer lasting. She had been a good stepmother to Marion's

two daughters, and had given him Christopher. Despite the twenty-year age difference between them, she understood his moods and could wean him out of his occasional depressions. Thanks to her, he could now contemplate the memory of Marion without grief, though not without a wistful sadness that would remain with him for the rest of his life.

Caroline was throwing fish to the largest dolphin - the big male they called Scarback - when a gentle tickling on Floyd's wrist announced an incoming call. He tapped the slim metal band to quench the silent alarm and forestall the audible one, then walked to the nearest of the comsets scattered around the room.

'Chancellor here. Who's calling?'

'Heywood? This is Victor. How are you?'

In a fraction of a second, a whole kaleidoscope of emotions flashed through Floyd's mind. First there was annoyance: his successor - and, he was sure, principal contriver of his downfall - had never once attempted to contact him since his departure from Washington. Then came curiosity: what did they have to talk about? Next was a stubborn determination to be as unhelpful as possible, then shame at his own childishness, and, finally, a surge of excitement. Victor Millson could be calling for only one reason.

In as neutral a voice as he could muster, Floyd answered:

'I can't complain, Victor. What's the problem?'

'Is this a secure circuit?'

'No, thank God. I don't need them any more.'

'Um. Well, I'll put it this way. You recall the last project you administered?'

'I'm not likely to forget, especially as the Subcommittee on Astronautics called me back to give more evidence only a month ago.'

'Of course, of course. I really must get around to reading your statement, when I have a moment. But I've been so busy with the follow-up, and that's the problem.'

'I thought that everything was right on schedule.'

'It is - unfortunately. There's nothing we can do to advance it; even the highest priority would make only a few weeks' difference. And that means we'll be too late.'

'I don't understand,' said Floyd innocently. 'Though we don't want to waste time, of course, there's no real deadline.'

'Now there is - and two of them.'

'You amaze me.'

If Victor noticed any irony, he ignored it. 'Yes, there are two deadlines - one man-made, one not. It now turns out that we won't be the first to get back to the - er, scene of the action. Our old rivals will beat us by at least a year.'

'Too bad.'

'That's not the worst. Even if there were no competition, we'd be too late. There wouldn't be anything there when we arrive.'

'That's ridiculous. I'm sure I'd have heard if Congress had repealed the law of gravitation.'

'I'm serious. The situation isn't stable - I can't give details now. Will you be in for the rest of the evening?'

'Yes,' Floyd answered, realizing with some pleasure that it must now be well after midnight in Washington.

'Good. You'll have a package delivered within the hour. Call me back as soon as you've had the time to study it.'

'Won't it be rather late by then?'

'Yes, it will be. But we've wasted too much time already. I don't want to lose any more.'

Millson was true to his word. Exactly an hour later a large sealed envelope was delivered by an Air Force colonel, no less, who sat patiently chatting with Caroline while Floyd read its contents. 'I'm afraid I'll have to take it away when you've finished,' the high-ranking messenger boy said apologetically.

'I'm glad to hear it,' Floyd answered, as he settled down in his favourite reading hammock.

There were two documents, the first very short. It was stamped TOP SECRET, though the TOP had been crossed out and the modification endorsed by three signatures, all completely illegible. Obviously an extract from some much longer report, it had been heavily censored and was full of blanks, which made it most annoying to read. Fortunately, its conclusions could be summed up in one sentence: The Russians would reach Discovery long before its rightful owners could do so. As Floyd already knew this, he turned quickly to the second document - though not before noticing with satisfaction that this time they'd managed to get the name right. As usual, Dimitri had been perfectly accurate. The next manned expedition to Jupiter would travel aboard spacecraft Cosmonaut Alexei Leonov.

The second document was much longer and was merely confidential; indeed, it was in the form of a draft letter to Science, awaiting final approval before publication. Its snappy title was 'Space Vehicle Discovery: Anomalous Orbital Behavior'.

Then followed a dozen pages of mathematics and astronomical tables. Floyd skimmed through these, picking out the words from the music, and trying to detect any note of apology or even embarrassment. When he had finished, he was compelled to give a smile of wry admiration. No one could possibly guess that the tracking stations and ephemeris calculators had been caught by surprise, and that a frantic cover-up was in progress. Heads would doubtless roll, and he knew that Victor Millson would enjoy rolling them - if his was not one of the first to go. Though to do him justice, Victor had complained when Congress had cut funds for the tracking network. Maybe that would get him off the hook.

'Thank you, Colonel,' said Floyd when he had finished skimming the papers. 'Quite like old times, having classified documents. That's one thing I don't miss.'

The colonel placed the envelope carefully back in his briefcase, and activated the locks.

'Dr Millson would like you to return his call as soon as possible.'

'I know. But I don't have a secure circuit, I've some important visitors coming shortly, and I'm damned if I'm driving down to your office in Hilo just to say I've read two documents. Tell him that I've studied them carefully and await any further communication with interest.'

For a moment it looked as if the colonel was going to argue. Then he thought better of it, made a stiff farewell, and departed morosely into the night.

'Now, what was all that about?' asked Caroline. 'We're not expecting any visitors tonight, important or otherwise.'

'I hate being pushed around, particularly by Victor Millson.'

'Bet he calls you back as soon as the colonel reports.'

'Then we must switch off video and make some party noises. But to be perfectly truthful, at this stage I really don't have anything to say.'

'About what, if I'm allowed to ask.'

'Sorry, dear. It seems that Discovery is playing tricks on us. We thought the ship was in a stable orbit, but it may be about to crash.'

'Into Jupiter?'

'Oh no - that's quite impossible. Bowman left it parked at the inner Lagrange point, on the line between Jupiter and Io. It should have stayed there, more or less, though the perturbations of the outer moons would have made it wander back and forth.'

'But what's happening now is something very odd, and we don't know the full explanation. Discovery's drifting more and more rapidly toward Io - though sometimes it accelerates, and sometimes even moves backward. If it keeps this up, it will impact within two or three years.'

'I thought this couldn't happen in astronomy. Isn't celestial mechanics supposed to be an exact science? So we poor backward biologists were always being told.'

'It is an exact science, when everything is taken into account. But some very strange things go on around Io. Apart from its volcanoes, there are tremendous electrical discharges - and Jupiter's magnetic field is spinning

round every ten hours. So gravitation isn't the only force acting on Discovery; we should have thought of this sooner - much sooner.'

'Well, it's not your problem anymore. You should be thankful for that.'

'Your problem' - the very expression that Dimitri had used. And Dimitri - cunning old fox! - had known him much longer than Caroline.

It might not be his problem, but it was still his responsibility. Though many others had been involved, in the final analysis he had approved the plans for the Jupiter Mission, and supervised their execution.

Even at the time, he had had qualms; his views as a scientist had conflicted with his duties as a bureaucrat. He could have spoken out, and opposed the old administration's shortsighted policies - though to what extent those had actually contributed to the disaster was still uncertain.

Perhaps it was best if he closed this chapter of his life, and focused all his thoughts and energies upon his new career. But in his heart he knew that was impossible; even if Dimitri had not revived old guilts, they would have surfaced of their own accord.

Four men had died, and one had disappeared, out there among the moons of Jupiter. There was blood on his hands, and he did not know how to wash them clean.

SAL 9000

Dr Sivasubramanian Chandrasegarampillai, Professor of Computer Science at the University of Illinois, Urbana, also had an abiding sense of guilt, but one very different from Heywood Floyd's. Those of his students and colleagues who often wondered if the little scientist was quite human would not have been surprised to learn that he never thought of the dead astronauts. Dr Chandra grieved only for his lost child, HAL 9000.

Even after all these years, and his endless reviews of the data radioed back from Discovery, he was not sure what had gone wrong. He could only formulate theories; the facts he needed were frozen in Hal's circuits, out there between Jupiter and Io.

The sequence of events had been clearly established, up to the moment of the tragedy; thereafter, Commander Bowman had filled in a few more details on the brief occasions when he had re-established contact. But knowing what happened did not explain why.

The first hint of trouble had been late in the mission, when Hal had reported the imminent failure of the unit that kept Discovery's main antenna aligned to Earth. If the half-billion-kilometre-long radio beam wandered off target, the ship would be blind, deaf, and dumb.

Bowman himself had gone out to retrieve the suspect unit, but when it was tested it appeared, to everyone's surprise, to be in perfectly good order. The automatic checking circuits could find nothing wrong with it. Nor could Hal's twin, SAL 9000, back on Earth, when the information was transmitted to Urbana.

But Hal had insisted on the accuracy of his diagnosis, making pointed remarks about 'human error'. He had suggested that the control unit be put back in the antenna until it finally failed, so that the fault could be precisely located. No one could think of any objection, for the unit could be replaced in minutes, even if it did break down.

Bowman and Poole, however, had not been happy; they both felt that something was wrong, though neither could pinpoint it. For months they had accepted Hal as the third member of their tiny world, and knew his every mood. Then the atmosphere aboard the ship had subtly altered; there was a sense of strain in the air.

Feeling rather like traitors - as a distraught Bowman had later reported to Mission Control - the human two-thirds of the crew had discussed what should be done if their colleague was indeed malfunctioning. In the worst possible case, Hal would have to be relieved of all his higher responsibilities. This would involve disconnection - the computer equivalent of death.

Despite their doubts, they had carried out the agreed programme. Poole had flown out of Discovery in one of the little space pods that served as transporters and mobile workshops during extravehicular activities. Since the somewhat tricky job of replacing the antenna unit could not be performed by the pod's own manipulators, Poole had started to do it himself.

What happened then had been missed by the external cameras, which was a suspicious detail in itself. Bowman's first warning of disaster was a cry from Poole - then, silence. A moment later he saw Poole, tumbling over and over, spinning away into space. His own pod had rammed him, and was itself blasting away out of control.

As Bowman admitted later, he had then made several serious mistakes - all but one excusable. In the hope of rescuing Poole, if he was still alive,

Bowman launched himself in another space pod - leaving Hal in full control of the ship.

The EVA was in vain; Poole was dead when Bowman reached him. Numb with despair, he had carried the body back to the ship - only to be refused entry by Hal.

But Hal had underestimated human ingenuity and determination. Though he had left his suit helmet in the ship, and thus had to risk direct exposure to space, Bowman forced his way in by an emergency hatch not under computer control. Then he proceeded to lobotomize Hal, unplugging his brain modules one by one.

When he regained control of the ship, Bowman made an appalling discovery. During his absence, Hal had switched off the life-support systems of the three hibernating astronauts. Bowman was alone, as no man had ever been before in the whole of human history.

Others might have abandoned themselves in helpless despair, but now David Bowman proved that those who had selected him had indeed chosen well. He managed to keep Discovery operational, and even re-established intermittent contact with Mission Control, by orienting the whole ship so that the jammed antenna pointed toward Earth.

On its preordained trajectory, Discovery had finally arrived at Jupiter. There Bowman had encountered, orbiting among the moons of the giant planet, a black slab of exactly the same shape as the monolith excavated in the lunar crater Tycho - but hundreds of times larger. He had gone out in a space pod to investigate, and had disappeared leaving that final, baffling message: 'My God, it's full of stars!'

That mystery was for others to worry about; Dr Chandra's overwhelming concern was with Hal. If there was one thing his unemotional mind hated, it was uncertainty. He would never be satisfied

until he knew the cause of Hal's behaviour. Even now, he refused to call it a malfunction; at most, it was an 'anomaly'.

The tiny cubbyhole he used as his inner sanctum was equipped only with a swivel chair, a desk console, and a blackboard flanked by two photographs. Few members of the general public could have identified the portraits, but anyone permitted thus far would have recognized them instantly as John von Neumann and Alan Turing, the twin gods of the computing pantheon.

There were no books, and not even paper and pencil on the desk. All the volumes in all the libraries of the world were instantly available at the touch of Chandra's fingers, and the visual display was his sketchbook and writing pad. Even the blackboard was used only for visitors; the last half-erased block diagram upon it bore a date already three weeks in the past.

Dr Chandra lit one of the venomous cheroots which he imported from Madras, and which were widely - and correctly - believed to be his only vice. The console was never switched off he checked that no messages were flashing importantly on the display, then spoke into the microphone.

'Good morning, Sal. So you've nothing new for me?'

'No, Dr Chandra. Have you anything for me?'

The voice might have been that of any cultured Hindu lady educated in the United States as well as her own country. Sal's accent had not started that way, but over the years she had picked up many of Chandra's intonations.

The scientist tapped out a code on the board, switching Sal's inputs to the memory with the highest security rating. No one knew that he talked to the computer on this circuit as he never could to a human being. No matter that Sal did not really understand more than a fraction of what he said; her responses were so convincing that even her creator was sometimes

deceived. As indeed he wished to be: these secret communications helped to preserve his mental equilibrium - perhaps even his sanity.

'You've often told me, Sal, that we cannot solve the problem of Hal's anomalous behaviour without more information. But how can we get that information?'

'That is obvious. Someone must return to Discovery.'

'Exactly. Now it looks as if that is going to happen, sooner than we expected.'

'I am pleased to hear that.'

'I knew that you would be,' answered Chandra, and meant it. He had long since broken off communications with the dwindling body of philosophers who argued that computers could not really feel emotions, but only pretended to do so.

('If you can prove to me that you're not pretending to be annoyed,' he had once retorted scornfully to one such critic, 'I'll take you seriously.' At that point, his opponent had put on a most convincing imitation of anger.)

'Now I want to explore another possibility,' Chandra continued. 'Diagnosis is only the first step. The process is incomplete unless it leads to a cure.'

'You believe that Hal can be restored to normal functioning?'

'I hope so. I do not know. There may have been irreversible damage, and certainly major loss of memory.'

He paused thoughtfully, took several puffs, then blew a skilful smoke ring that scored a bull's-eye on Sal's wideangle lens. A human being would

not have regarded this as a friendly gesture; that was yet another of the many advantages of computers.

'I need your cooperation, Sal.'

'Of course, Dr Chandra.'

'There may be certain risks.'

'What do you mean?'

'I propose to disconnect some of your circuits, particularly those involving your higher functions. Does this disturb you?'

'I am unable to answer that without more specific information.'

'Very well. Let me put it this way. You have operated continuously, have you not, since you were first switched on?'

'That is correct.'

'But you are aware that we human beings cannot do so. We require sleep - an almost complete break in our mental functioning, at least on the conscious level.'

'I know this. But I do not understand it.'

'Well, you may be about to experience something like sleep. Probably all that will happen is that time will pass, but you will be unaware out. When you check your internal clock, you will discover that there are gaps in your monitor record. That is all.'

'But you said that there might be risks. What are they?'

'There is a very slight chance - it is impossible to compute it - that when I reconnect your circuits, there may be some changes in your personality, your future behaviour patterns. You may feel different. Not necessarily better, or worse.'

'I do not know what that means.'

'I'm sorry - it may not mean anything. So don't worry about it. Now please open a new file - here is the name.' Using the keyboard input, Chandra typed out: PHOENIX.

'Do you know what that is?' he asked Sal.

With no discernible pause the computer replied: 'There are twenty-five references in the current encyclopedia.'

'Which one do you think is relevant?'

'The tutor of Achilles?'

'Interesting. I didn't know that one. Try again.'

'A fabulous bird, reborn from the ashes of its earlier life.'

'Excellent. Now do you understand why I chose it?'

'Because you hope that Hal can be reactivated.'

'Yes - with your assistance. Are you ready?'

'Not yet. I would like to ask a question.'

'What is it?'

'Will I dream?'

'Of course you will. All intelligent creatures dream - but no one knows why.' Chandra paused for a moment, blew another smoke ring from the cheroot, and added something that he would never admit to a human being. 'Perhaps you will dream about Hal - as I often do.'

4

Mission Profile

English Version

To: Captain Tatiana (Tanya) Orlova, Commander. Spacecraft
Cosmonaut Alexei Leonov (UNCOS Registration 081342).

From: National Council on Astronautics, Pennsylvania Avenue,
Washington

Commission on Outer Space, USSR Academy of Science, Korolyev
Prospect, Moscow

Mission Objectives

The objectives of your mission are, in order of priority:

1. To proceed to the Jovian system and rendezvous with US Spacecraft Discovery (UNCOS 01/283).

2. To board this spacecraft, and obtain all possible information relating to its earlier mission.

3. To reactivate Spacecraft Discovery's onboard systems and, if propellant supplies are adequate, inject the ship into an Earth-returns trajectory.

4 To locate the alien artifact encountered by Discovery, and to investigate it to the maximum extent possible by remote sensors.

5. If it seems advisable, and Mission Control concurs, to rendezvous with this object for closer inspection.

6. To carry out a survey of Jupiter and its satellites, as far as this is compatible with the above objectives.

It is realized that unforeseen circumstances may require a change of priorities, or even make it impossible to achieve some of these objectives. It must be clearly understood that the rendezvous with Spacecraft Discovery is for the express purpose of obtaining information about the artifact; this must take precedence over all other objectives, including attempts at salvage.

Crew

The crew of Spacecraft Alexei Leonov will consist of:

Captain Tatiana Orlova (Engineering-Propulsion)

Dr Vasili Orlov (Navigation-Astronomy)

Dr Maxim Brailovsky (Engineering-Structures)

Dr Alexander Kovalev (Engineering-Communications)

Dr Nikolai Ternovsky (Engineering-Control Systems)

Surgeon-Commander Katerina Rudenko (Medical-Life-Support)

Dr Irma Yakunina (Medical-Nutrition)

In addition, the US National Council on Astronautics will provide the following three experts:

Dr Heywood Floyd dropped the memorandum, and leaned back in his chair. It was all settled; the point of no return had been passed. Even if he wished to do so, there was no way to put back the clock.

He glanced across at Caroline, sitting with two-year-old Chris on the edge of the pool. The boy was more at home in the water than on land, and could stay submerged for periods that often terrified visitors. And though he could not yet speak much Human, he already seemed fluent in Dolphin.

One of Christopher's friends had just swum in from the Pacific and was presenting his back to be patted. You too are a wanderer, thought Floyd, in a vast and trackless ocean; but how small your tiny Pacific seems, against the immensity I am facing now!

Caroline became aware of his gaze, and rose to her feet. She looked at him sombrely, but without anger; all that had been burned out in the last few days. As she approached, she even managed a wistful smile.

'I've found that poem I was looking for,' she said. 'It starts like this:

What is a woman that you forsake her,
And the hearth-fire and the home acre,
To go with the old grey Widow-maker?'

'Sorry - I don't quite understand. Who is the Widow-maker?'

'Not who, what. The sea. The poem's a lament by a Viking woman. It was written by Rudyard Kipling, a hundred years ago.'

Floyd took his wife's hand; she did not respond, but neither did she resist.

'Well, I don't feel at all like a Viking. I'm not after loot, and adventure is the very last thing I want.'

'Then why - no, I don't intend to start another fight. But it would help us both, if you know exactly what your motives are.'

'I wish I could give you one single good reason. Instead, I've a whole host of little ones. But they add up to a final answer I can't argue with - believe me.'

'I believe you. But are you sure you're not fooling yourself?'

'If I am, then so are a lot of other people. Including, may I remind you, the President of the United States.'

'I'm not likely to forget. But suppose - just suppose - that he hadn't asked you. Would you have volunteered?'

'I can answer that truthfully: No. It would never have occurred to me. President Mordecai's call was the biggest shock of my life. But when I thought it over, I realized he was perfectly right. You know I don't go in for false modesty. I am the best-qualified man for the job - when the space docs give their final okay. And you should know that I'm still in pretty good shape.'

That brought the smile he had intended.

'Sometimes I wonder if you'd suggested it yourself.'

The thought had indeed occurred to him; but he could answer honestly.

'I would never have done so without consulting you.'

'I'm glad you didn't. I don't know what I'd have said.'

'I could still turn it down.'

'Now you're talking nonsense, and you know it. Even if you did, you'd hate me for the rest of your life - and you'd never forgive yourself. You have too strong a sense of duty. Maybe that's one of the reasons I married you.'

Duty! Yes, that was the key word, and what multitudes it contained. He had a duty to himself, to his family, to the University, to his past job (even though he had left it under a cloud), to his country - and to the human race. It was not easy to establish the priorities; and sometimes they conflicted with one another.

There were perfectly logical reasons why he should go on the mission - and equally logical reasons, as many of his colleagues had already pointed out, why he should not. But perhaps in the final analysis, the choice had

been made by his heart, not his brain. And even here, emotion urged him in two opposite directions.

Curiosity, guilt, the determination to finish a job that had been badly botched - they all combined to drive him toward Jupiter and whatever might be waiting there. On the other hand, fear - he was honest enough to admit that - united with love of his family to keep him on Earth. Yet he had never had any real doubts; he had made his decision almost instantly, and had deflected all of Caroline's arguments as gently as he could.

And there was one other consoling thought that he had not yet risked sharing with his wife. Though he would be gone two and a half years, all but the fifty days at Jupiter would be spent in timeless hibernation. When he returned, the gap between their ages would have narrowed by more than two years.

He would have sacrificed the present so that they could share a longer future together.

5

Leonov

The months contracted to weeks, the weeks dwindled to days, the days shrivelled to hours; and suddenly Heywood Floyd was once more at the Cape - spaceward-bound for the first time since that trip to Clavius Base and the Tycho monolith, so many years ago.

But this time he was not alone, and there was no secrecy about the mission. A few seats ahead of him rode Dr Chandra, already engaged in a

dialogue with his briefcase computer, and quite oblivious to his surroundings.

One of Floyd's secret amusements, which he had never confided to anyone, was spotting similarities between human beings and animals. The resemblances were more often flattering than insulting, and his little hobby was also a very useful aid to memory.

Dr Chandra was easy - the adjective birdlike sprang instantly to mind. He was tiny, delicate, and all his movements were swift and precise. But which bird? Obviously a very intelligent one. Magpie? Too perky and acquisitive. Owl? No - too slow-moving. Perhaps sparrow would do nicely.

Walter Curnow, the systems specialist who would have the formidable job of getting Discovery operational again, was a more difficult matter. He was a large, husky man, certainly not at all birdlike. One could usually find a match somewhere in the vast spectrum of dogs, but no canine seemed to fit. Of course - Curnow was a bear. Not the sulky, dangerous kind, but the friendly good-natured type. And perhaps this was appropriate; it reminded Floyd of the Russian colleagues he would soon be joining. They had been up in orbit for days, engaged in their final checks.

This is the great moment of my life, Floyd told himself. Now I am leaving on a mission that may determine the future of the human race. But he did not feel any sense of exultation; all he could think of, during the last minutes of the countdown, were the words he had whispered just before he had left home: 'Goodbye, my dear little son; will you remember me when I return?' And he still felt resentment toward Caroline because she would not awaken the sleeping child for one final embrace; yet he knew that she had been wise, and it was better that way.

His mood was shattered by a sudden explosive laugh; Dr Curnow was sharing a joke with his companions - as well as a large bottle that he handled as delicately as a barely subcritical mass of plutonium.

'Hey, Heywood,' he called, 'they tell me Captain Orlova's locked up all the drinks, so this is your last chance. Château Thierry '95. Sorry about the plastic cups.'

As Floyd sipped at the really superb champagne, he found himself cringing mentally at the thought of Curnow's guffaw reverberating all the way across the Solar System. Much as he admired the engineer's, ability, as a travelling companion Curnow might prove something of a strain. At least Dr Chandra would not present such problems; Floyd could hardly imagine him smiling, let alone laughing. And, of course, he turned down the champagne with a barely perceptible shudder. Curnow was polite enough, or glad enough, not to insist.

The engineer was, it seemed, determined to be the life and soul of the party. A few minutes later he produced a two-octave electronic keyboard, and gave rapid renderings of 'D'ye ken John Peel' as performed successively by piano, trombone, violin, flute, and full organ, with vocal accompaniment. He was really very good, and Floyd soon found himself singing along with the others. But it was just as well, he thought, that Curnow would spend most of the voyage in silent hibernation.

The music died with a sudden despairing discord as the engines ignited and the shuttle launched itself into the sky. Floyd was gripped by a familiar but always new exhilaration - the sense of boundless power, carrying him up and away from the cares and duties of Earth. Men knew better than they realized, when they placed the abode of the gods beyond the reach of gravity. He was flying toward that realm of weightlessness; for the moment, he would ignore the fact that out there lay not freedom, but the greatest responsibility of his career.

As the thrust increased, he felt the weight of worlds upon his shoulders - but he welcomed it, like an Atlas who had not yet tired of his burden. He did not attempt to think, but was content to savour the experience. Even if he was leaving Earth for the last time, and saying farewell to all that he

had ever loved, he felt no sadness. The roar that surrounded him was a paean of triumph, sweeping away all minor emotions.

He was almost sorry when it ceased, though he welcomed the easier breathing and the sudden sense of freedom. Most of the other passengers started to unbuckle their safety straps, preparing to enjoy the thirty minutes of zero gravity during the transfer orbit, but a few who were obviously making the trip for the first time remained in their seats, looking around anxiously for the cabin attendants.

'Captain speaking. We're now at an altitude of three hundred kilometres, coming up over the west coast of Africa. You won't see much as it's night down there - that glow ahead is Sierra Leone - and there's a big tropical storm over the Gulf of Guinea. Look at those flashes!

'We'll have sunrise in fifteen minutes. Meanwhile I'm rolling the ship so you can get a good view of the equatorial satellite belt. The brightest one - almost straight overhead - is Intelsat's Atlantic-1 Antenna Farm. Then Intercosmos 2 to the west - that fainter star is Jupiter. And if you look just below that, you'll see a flashing light, moving against the star background - that's the new Chinese space-station. We pass within a hundred kilometres, not close enough to see anything with the naked eye -,

What were they up to? Floyd thought idly. He had examined the close-ups of the squat cylindrical structure with its curious bulges, and saw no reason to believe the alarmist rumours that it was a laser-equipped fortress. But while the Beijing Academy of Science ignored the UN Space Committee's repeated requests for a tour of inspection, the Chinese only had themselves to blame for such hostile propaganda.

The "Cosmonaut Alexei Leonov" was not a thing of beauty; but few spacecraft ever were. One day, perhaps, the human race would develop a new aesthetic; generations of artists might arise whose ideals were not

based upon the natural forms of Earth moulded by wind and water. Space itself was a realm of often overpowering beauty; unfortunately, Man's hardware did not yet live up to it.

Apart from the four huge propellant tanks, which would be dropped off as soon as the transfer orbit was achieved, Leonov was surprisingly small. From heat shield to drive units was less than fifty metres; it was hard to believe that so modest a vehicle, smaller than many commercial aircraft, could carry ten men and women halfway across the Solar System.

But zero gravity, which made walls and roof and floor interchangeable, rewrote all the rules of living. There was plenty of room aboard Leonov even when everyone was awake at the same time, as was certainly the case at the moment. Indeed, her normal complement was at least doubled by assorted newsmen, engineers making final adjustments, and anxious officials.

As soon as the shuttle had docked, Floyd tried to find the cabin he would share - a year hence, when he awoke - with Curnow and Chandra. When he did locate it, he discovered that it was packed so tightly with neatly labelled boxes of equipment and provisions that entry was almost impossible. He was wondering glumly how to get a foot in the door when one of the crew, launching himself skilfully from handhold to handhold, noticed Floyd's dilemma and braked to a halt.

'Dr Floyd - welcome aboard. I'm Max Brailovsky - assistant engineer.'

The young Russian spoke the slow, careful English of a student who had had more lessons with an electronic tutor than a human teacher. As they shook hands, Floyd matched the face and name to the set of crew biographies he had already studied: Maxim Andreievitch Brailovsky, age thirty-one, born Leningrad, specializing in structure; hobbies: fencing, skycycling, chess.

'Glad to meet you,' said Floyd. 'But how do I get inside?'

'Not to worry,' said Max cheerfully. 'All that will be gone when you wake up. It's - what do you say? - expendables. We'll eat your room empty by the time you need it. I promise.' He patted his stomach.

'Fine - but meanwhile where do I put my things?' Floyd pointed to the three small cases, total mass fifty kilograms, which contained - he hoped - everything he needed for the next couple of billion kilometres. It had been no easy task, shepherding their weightless, but not inertialess, bulk through the ship's corridors with only a few collisions.

Max took two of the bags, glided gently through the triangle formed by three intersecting girders, and dived into a small hatchway, apparently defying Newton's First Law in the process. Floyd acquired a few extra bruises while following him; after a considerable time - Leonov seemed much bigger inside than out- they arrived at a door labelled CAPTAIN, in both Cyrillic and Roman. Although he could read Russian much better than he could speak it, Floyd appreciated the gesture; he had already noticed that all ship's notices were bilingual.

At Max's knock, a green light flashed on, and Floyd drifted inside as gracefully as he could. Though he had spoken to Captain Orlova many times, they had never before met. So he had two surprises.

It was impossible to judge a person's real size over the viewphone; the camera somehow converted everyone to the same scale. Captain Orlova, standing - as well as one could stand in zero gravity - barely reached to Floyd's shoulders. The viewphone had also completely failed to convey the penetrating quality of those dazzling blue eyes, much the most striking feature of a face that, at the moment, could not be fairly judged for beauty.

'Hello, Tanya,' said Floyd. 'How nice to meet at last. But what a pity about your hair.'

They grasped both hands, like old friends.

'And nice to have you aboard, Heywood!' answered the captain. Her English, unlike Brailovsky's, was quite fluent, though heavily accented. 'Yes, I was sorry to lose it - but hair's a nuisance on long missions, and I like to keep the local barbers away as long as possible. And my apologies about your cabin; as Max will have explained, we suddenly found we needed another ten cubic metres of storage space. Vasili and I won't be spending much time here for the next few hours - please feel free to use our quarters.'

'Thank you. What about Curnow and Chandra?'

'I've made similar arrangements with the crew. It may seem as if we're treating you like cargo -'

'Not wanted on voyage.'

'Pardon?'

'That's a label they used to put on the baggage, in the old days of ocean travel.'

Tanya smiled. 'It does look rather that way. But you'll be wanted all right, at the end of the trip. We're already planning your revival party.'

'That sounds too religious. Make it - no, resurrection would be even worse! - waking-up party. But I can see how busy you are - let me dump my things and continue my grand tour.'

'Max will show you around - take Dr Floyd to Vasili, will you? He's down in the drive unit.'

As they drifted out of the captain's quarters, Floyd gave mental good marks to the crew-selection committee. Tanya Orlova was impressive enough on paper; in the flesh she was almost intimidating, despite her

charm. I wonder what she's like, Floyd asked himself, when she loses her temper. Would it be fire or ice? On the whole, I'd prefer not to find out.

Floyd was rapidly acquiring his space legs; by the time they reached Vasili Orlov, he was manoeuvring almost as confidently as his guide. The chief scientist greeted Floyd as warmly as his wife had.

'Welcome aboard, Heywood. How do you feel?'

'Fine, apart from slowly starving to death.'

For a moment Orlov looked puzzled; then his face split into a broad smile,

'Oh, I'd forgotten. Well, it won't be for long. In ten months' time, you can eat as much as you like.'

Hibernators went on a low-residue diet a week in advance; for the last twenty-four hours, they took nothing but liquid. Floyd was beginning to wonder how much of his increasing light-headedness was due to starvation, how much to Curnow's champagne, and how much to zero gravity.

To concentrate his mind, he scanned the multicoloured mass of plumbing that surrounded them.

'So this is the famous Sakharov Drive. It's the first time I've seen a full-scale unit.'

'It's only the fourth one ever built.'

'I hope it works.'

'It had better. Otherwise, the Gorky City Council will be renaming Sakharov Square again.'

It was a sign of the times that a Russian could joke, however wryly, about his country's treatment of its greatest scientist. Floyd was again reminded of Sakharov's eloquent speech to the Academy, when he was belatedly made Hero of the Soviet Union. Prison and banishment, he had told his listeners, were splendid aids to creativity; not a few masterpieces had been born within the walls of cells, beyond the reach of the world's distractions. For that matter, the greatest single achievement of the human intellect, the Principia itself, was a product of Newton's self-imposed exile from plague-ridden London.

The comparison was not immodest; from those years in Gorky had come not only new insights into the structure of matter and the origin of the Universe, but the plasma-controlling concepts that had led to practical thermonuclear power. The drive itself, though the best-known and most publicized outcome of that work, was merely one byproduct of that astonishing intellectual outburst. The tragedy was that such advances had been triggered by injustice; one day, perhaps, humanity would find more civilized ways of managing its affairs.

By the time they had left the chamber, Floyd had learned more about the Sakharov Drive than he really wished to know, or expected to remember. He was well acquainted with its basic principles - the use of a pulsed thermonuclear reaction to heat and expel virtually any propellant material. The best results were obtained with pure hydrogen as a working fluid, but that was excessively bulky and difficult to store over long periods of time. Methane and ammonia were acceptable alternatives; even water could be used, though with considerably poorer efficiency.

Leonov would compromise; the enormous liquid hydrogen tanks that provided the initial impetus would be discarded when the ship had attained the necessary speed to carry it to Jupiter. At the destination, ammonia would be used for the braking and rendezvous manoeuvres, and the eventual return to Earth.

That was the theory, checked and rechecked in endless tests and computer simulations. But as the ill-fated Discovery had shown so well, all human plans were subject to ruthless revision by Nature, or Fate, or whatever one preferred to call the powers behind the Universe.

'So there you are, Dr Floyd,' said an authoritative female voice, interrupting Vasili's enthusiastic explanation of magnetohydrodynamic feedback, 'Why didn't you report to me?'

Floyd rotated slowly on his axis by gently torquing himself with one hand. He saw a massive, maternal figure wearing a curious uniform adorned with dozens of pockets and pouches; the effect was not unlike that of a Cossack trooper draped with cartridge belts.

'Nice to meet you again, Doctor. I'm still exploring - I hope you've received my medical report from Houston.'

'Those vets at Teague! I wouldn't trust them to recognize foot-and-mouth disease!'

Floyd knew perfectly well the mutual respect felt between Katerina Rudenko and the Olin Teague Medical Center, even if the doctor's broad grin had not discounted her words. She saw his look of frank curiosity, and proudly fingered the webbing around her ample waist.

'The conventional little black bag isn't very practical in zero gravity - things float out of it and aren't there when you need them. I designed this myself, it's a complete minisurgery. With this, I could remove an appendix - or deliver a baby.'

'I trust that particular problem won't arise here.'

'Ha! A good doctor has to be ready for everything.'

What a contrast, thought Floyd, between Captain Orlova and Dr - or should he call her by her correct rank of Surgeon-Commander? - Rudenko. The captain had the grace and intensity of a prima ballerina; the doctor might have been the prototype of Mother Russia - stocky build, flat peasant face, needing only a shawl to complete the picture. Don't let that fool you, Floyd told himself. This is the woman who saved at least a dozen lives during the Komarov docking accident - and, in her spare time, manages to edit the Annals of Space Medicine. Consider yourself very lucky to have her aboard.

'Now, Dr Floyd, you're going to have plenty of time later to explore our little ship. My colleagues are too polite to say this, but they've work to do and you're in the way. I'd like to get you - all three of you - nice and peaceful as quickly as we can. Then we'll have less to worry about.'

'I was afraid of that, but I quite see your point of view. I'm ready as soon as you are.'

'I'm always ready. Come along - please.'

The ship's hospital was just large enough to hold an operating table, two exercise bicycles, a few cabinets of equipment, and an X-ray machine. While Dr Rudenko was giving Floyd a quick but thorough examination, she asked unexpectedly: 'What's that little gold cylinder Dr Chandra carries on the chain around his neck - some kind of communications device? He wouldn't take it off - in fact, he was almost too shy to take anything off.'

Floyd could not help smiling; it was easy to imagine the modest Indian's reactions to this rather overwhelming lady.

'It's a lingam.'

'A what?'

'You're the doctor - you ought to recognize it. The symbol of male fertility.'

'Of course - stupid of me. Is he a practising Hindu? It's a little late to ask us to arrange a strict vegetarian diet.'

'Don't worry - we wouldn't have done that to you without fair warning. Though he won't touch alcohol, Chandra's not fanatical about anything except computers. He once told me that his grandfather was a priest in Benares, and gave him that lingam - it's been in the family for generations.'

Rather to Floyd's surprise, Dr Rudenko did not show the negative reaction he had expected; indeed, her expression became uncharacteristically wistful.

'I understand his feeling. My grandmother gave me a beautiful icon - sixteenth century. I wanted to bring it - but it weighs five kilos.'

The doctor became abruptly businesslike again, gave Floyd a painless injection with a gas-gun hypodermic, and told him to come back as soon as he was sleepy. That, she assured him, would be in less than two hours.

'Meanwhile, relax completely,' she ordered. 'There's an observation port on this level - Station D.6. Why don't you go there?'

It seemed a good idea, and Floyd drifted away with a docility that would have surprised his friends. Dr Rudenko glanced at her watch, dictated a brief entry into her autosec, and set its alarm thirty minutes ahead.

When he reached the D.6 viewport, Floyd found Chandra and Curnow already there. They looked at him with a total lack of recognition, then

turned once more toward the awesome spectacle outside. It occurred to Floyd - and he congratulated himself on such a brilliant observation - that Chandra could not really be enjoying the view. His eyes were tightly closed,

A totally unfamiliar planet hung there, gleaming with glorious blues and dazzling whites. How strange, Floyd told himself. What has happened to the Earth? Why, of course - no wonder he didn't recognize it! It was upside down! What a disaster - he wept briefly for all those poor people, falling off into space..

He barely noticed when two crew members removed Chandra's unresisting form. When they came back for Curnow, Floyd's own eyes were shut, but he was still breathing. When they returned for him, even his breathing had ceased.



TSIEN

Awakening

And they told us we wouldn't dream, thought Heywood Floyd, more with surprise than annoyance. The glorious pink glow that surrounded him was very soothing; it reminded him of barbecues and the crackling logs of Christmas fire. But there was no warmth; indeed, he felt a distinct though not uncomfortable coldness.

Voices were murmuring, just too softly for him to understand the words. They became louder - but still he could not understand.

'Surely,' he said in sudden amazement, 'I can't be dreaming in Russian!'

'No, Heywood,' answered a woman's voice. 'You're not dreaming. It's time to get out of bed.'

The lovely glow faded; he opened his eyes, and had a blurred glimpse of a flashlight being withdrawn from his face. He was lying on a couch, held against it by elastic webbing; figures were standing around him, but they were too out of focus to identify.

Gentle fingers closed his eyelids and massaged his forehead.

'Don't exert yourself. Breathe deeply... again... that's right... now how do you feel?'

'I don't know... strange... light-headed... and hungry.'

'That's a good sign. Do you know where you are? You can open your eyes now.'

The figures came into focus - first Dr Rudenko, then Captain Orlova. But something had happened to Tanya since he had seen her, only an hour ago. When Floyd identified the cause, it was almost a physical shock.

'You've grown your hair back!'

'I hope you think it's an improvement. I can't say the same about your beard.'

Floyd lifted his hand to his face, finding that he had to make a conscious effort to plan every stage of the movement. His chin was covered with short stubble - a two or three days' growth. In hibernation, hair grew at only a hundredth of its normal rate.

'So I made it,' he said. 'We've arrived at Jupiter.'

Tanya looked at him sombrely, then glanced at the doctor, who gave a barely perceptible nod.

'No, Heywood,' she said. 'We're still a month away. Don't be alarmed - the ship's fine, and everything's running normally. But your friends in Washington have asked us to wake you up ahead of time. Something very unexpected has happened. We're in a race to reach Discovery - and I'm afraid we're going to lose.'

Tsien

When Heywood Floyd's voice came from the comset speaker, the two dolphins suddenly stopped circling around the pool and swam over to its edge. They placed their heads on the rim and stared intently at the source of the sound.

So they recognize Heywood, thought Caroline, with a twinge of bitterness: Yet Christopher, crawling around his playpen, did not even stop playing with the colour controls of his picture book as his father's voice came loud and clear across half a billion kilometres of space.

'... My dear, you won't be surprised to hear from me, a month ahead of schedule; you'll have known for weeks that we have company out here.

'I still find it hard to believe; in some ways, it doesn't even make sense. They can't possibly have enough fuel for a safe return to Earth; we don't even see how they can make the rendezvous.

'We never saw them, of course. Even at its closest, Tsien was more than fifty million kilometres away. They had plenty of time to answer our signals if they wanted to, but they ignored us completely. Now they'll be much too busy for friendly chat. In a few hours they'll hit Jupiter's atmosphere - and then we'll see how well their aerobraking system works. If it does its job, that will be good for our morale. But if it fails, well, let's not talk about that.

'The Russians are taking it remarkably well, all things considered. They're angry and disappointed, of course - but I've heard many

expressions of frank admiration. It was certainly a brilliant trick, building that ship in full view and making everyone think it was a spacestation until they hitched on those boosters.

'Well, there's nothing we can do, except watch. And at our distance, we won't have a much better view than your best telescopes. I can't help wishing them luck, though of course I hope they leave Discovery alone. That's our property, and I bet the State Department's reminding them of it, every hour on the hour.

'It's an ill wind - if our Chinese friends hadn't jumped the gun on us, you wouldn't have heard from me for another month. But now that Dr Rudenko's woken me up, I'll be speaking to you every couple of days.

'After the initial shock, I'm settling down nicely- getting to know the ship and its crew, finding my space legs. And polishing up my lousy Russian, though I don't have much chance of using it - everyone insists on speaking English.

What shocking linguists we Americans are! I sometimes feel ashamed of our chauvinism - or our laziness.

'The standard of on-board English ranges from absolutely perfect - Chief Engineer Sasha Kovalev could earn a living as a BBC announcer - down to the if-you-talk-fast-enough-it-doesn't-matter-how-many-mistakes-you-make variety. The only one who isn't fluent is Zenia Marchenko, who replaced Irma Yakunina at the last moment. Incidentally, I'm glad to hear that Irma made a good recovery - what a disappointment that must have been! I wonder if she's started hang-gliding again.

'And speaking of accidents, it's obvious that Zenia must also have had a very bad one. Though the plastic surgeons have done a remarkable job, you can tell that she must have been severely burned at some time. She's the baby of the crew and the others treat her with - I was going to say pity, but that's too condescending. Let's say with special kindness.

'Maybe you're wondering how I get on with Captain Tanya. Well, I like her very much - but I'd hate to make her angry. There's no doubt exactly who runs this ship.

'And Surgeon-Commander Rudenko - you met her at the Honolulu Aerospace Convention two years ago, and I'm sure you won't have forgotten that last party. You'll understand why we all call her Catherine the Great - behind her broad back, of course.

'But that's enough gossip. If I run overtime, I hate to think of the surcharge. And by the way, these personal calls are supposed to be completely private. But there are a lot of links in the communications chain, so don't be surprised if you occasionally get messages by - well, another route.

'I'll be waiting to hear from you - tell the girls I'll be speaking to them later. My love to you all - I miss you and Chris very badly. And when I get back, I promise I'll never leave again.'

There was a brief hissing pause, then an obviously synthetic voice said: 'This terminates Transmission Four Hundred Thirty-two Stroke Seven from Spacecraft Leonov.' As Caroline Floyd switched off the speaker, the two dolphins slid beneath the surface of the pool and glided out into the Pacific, leaving scarcely a ripple in the water.

When he realized that his friends were gone, Christopher began to cry. His mother picked him up in her arms and tried to comfort him, but it was a long time before she succeeded.

Transit of Jupiter

The image of Jupiter, with its ribbons of white cloud, its mottled bands of salmon pink, and the Great Red Spot staring out like a baleful eye, hung steady on the flight-deck projection screen. It was three-quarters full, but no one was looking at the illuminated disk; all eyes were focused on the crescent of darkness at its edge. There, over the nightside of the planet, the Chinese ship was about to meet its moment of truth.

This is absurd, thought Floyd. We can't possibly see anything across forty million kilometres. And it doesn't matter; the radio will tell us all we want to know.

Tsien had closed down all voice, video, and data circuits two hours before, as the long-range antennas were withdrawn into the protective shadow of the heat shield. Only the omnidirectional beacon was still transmitting, accurately pinpointing the Chinese ship's position as it plunged toward that ocean of continent-sized clouds. The shrill beep... beep... beep... was the only sound in Leonov's control room. Each of those pulses had left Jupiter more than two minutes earlier; by this time, their source might already be a cloud of incandescent gas, dispersing in the Jovian stratosphere.

The signal was fading, becoming noisy. The beeps were getting distorted; several dropped out completely, then the sequence returned. A plasma sheath was building up around Tsien and soon would cut off all communications until the ship re-emerged. If it ever did.

'Posmotri!' cried Max. 'There it is!'

At first Floyd could see nothing. Then, just off the edge of the illuminated disk, he made out a tiny star - gleaming where no star could possibly be, against the darkened face of Jupiter.

It appeared quite motionless, though he knew it must be moving at a hundred kilometres a second. Slowly it grew in brilliance; and then it was no longer a dimensionless point, but was becoming elongated. A man-made comet was streaking across the Jovian night sky, leaving a trail of incandescence thousands of kilometres in length.

One last badly distorted and curiously drawn-out beep sounded from the tracking beacon, then only the meaningless hiss of Jupiter's own radiation, one of those many cosmic voices that had nothing to do with Man or his works.

Tsien was inaudible, but not yet invisible. For they could see that the tiny elongated spark had indeed moved appreciably away from the sunward face of the planet and would soon disappear into the night side. By then, if all had gone according to plan, Jupiter would have captured the ship, destroying its unwanted velocity. When it emerged from behind the giant world, it would be another Jovian satellite.

The spark flickered out. Tsien had rounded the curve of the planet and was heading over the night side. There would be nothing to see, or to hear, until it emerged from shadow - if all went well, in just under an hour. It would be a very long hour for the Chinese.

To Chief Scientist Vasili Orlov and communications engineer Sasha Kovalev, the hour went extremely quickly. There was much they could learn from observations of that little star; its times of appearance and disappearance and, above all, the Doppler shift of the radio beacon gave vital information about Tsien's new orbit. Leonov's computers were already digesting the figures, and spitting out projected times of re-emergence based on various assumptions about rates of deceleration in the Jovian atmosphere.

Vasili switched off the computer display, spun around in his chair, loosened his seat belt, and addressed the patiently waiting audience.

'Earliest reappearance is in forty-two minutes. Why don't you spectators go for a walk, so we can concentrate on getting all this into good shape? See you in thirty-five minutes. Shoo! Nu ukhodi!'

Reluctantly, the unwanted bodies left the bridge - but, to Vasili's disgust, everyone was back again in little more than thirty minutes. He was still chiding them for their lack of faith in his calculations when the familiar beep... beep... beep... of Tsien's tracking beacon burst from the loudspeakers.

Vasili looked astonished and mortified, but soon joined in the spontaneous round of applause; Floyd could not see who first started the clapping. Rivals though they might be, they were all astronauts together, as far from home as any men had ever travelled - 'Ambassadors for Mankind', in the noble words of the first UN Space Treaty. Even if they did not want the Chinese to succeed, neither did they wish them to meet disaster.

A large element of self-interest was also involved, Floyd could not help thinking. Now the odds in Leonov's own favour were significantly improved; Tsien had demonstrated that the aerobraking manoeuvre was indeed possible. The data on Jupiter was correct; its atmosphere did not contain unexpected and perhaps fatal surprises.

'Well!' said Tanya. 'I suppose we should send them a message of congratulations. But even if we did, they wouldn't acknowledge it.'

Some of his colleagues were still making fun of Vasili, who was staring at his computer output in frank disbelief.

'I don't understand it!' he exclaimed. 'They should still be behind Jupiter! Sasha - give me a velocity reading on their beacon!'

Another silent dialogue was held with the computer; then Vasili gave a long, low whistle.

'Something's wrong. They're in a capture orbit, all right - but it won't let them make a rendezvous with Discovery. The orbit they're on now will take them way beyond Io - I'll have more accurate data when we've tracked them for another five minutes.'

'Anyway, they must be in a safe orbit,' said Tanya. 'They can always make corrections later.'

'Perhaps. But that could cost them days, even if they have the fuel. Which I doubt.'

'So we may still beat them.'

'Don't be such an optimist. We're still three weeks from Jupiter. They can make a dozen orbits before we get there, and choose the most favourable one for a rendezvous.'

'Again - assuming that they have enough propellant.'

'Of course. And that's something we can only make educated guesses about.'

All this conversation took place in such rapid and excited Russian that Floyd was left far behind. When Tanya took pity on him and explained that Tsien had overshot and was heading for the outer satellites, his first reaction was: 'Then they may be in serious trouble. What will you do if they appeal for help?'

'You must be making a joke. Can you imagine them doing that? They're much too proud. Anyway, it would be impossible. We can't change our mission profile, as you know perfectly well. Even if we had the fuel...'

'You're right, of course; but it might be difficult to explain that to the ninety-nine per cent of the human race that doesn't understand orbital mechanics. We should start thinking about some of the political complications - it would look bad for all of us if we can't help. Vasili, will you give me their final orbit, as soon as you've worked it out? I'm going down to my cabin to do some homework.'

Floyd's cabin, or rather one-third of a cabin, was still partly full of stores, many of them stacked in the curtained bunks that would be occupied by Chandra and Curnow when they emerged from their long slumbers. He had managed to clear a small working space for his personal effects and had been promised the luxury of another whole two cubic metres - just as soon as someone could be spared to help with the furniture removing.

Floyd unlocked his little communications console, set the decryption keys, and called for the information on Tsien that had been transmitted to him from Washington. He wondered if his hosts had had any luck in unscrambling it; the cipher was based on the product of two hundred-digit prime numbers, and the National Security Agency had staked its reputation on the claim that the fastest computer in existence could not crack it before the Big Crunch at the end of the Universe. It was a claim that could never be proved - only disproved.

Once again he stared intently at the excellent photographs of the Chinese ship, taken when it had revealed its true colours and was just about to leave Earth orbit. There were later shots - not so clear, because by then it had been far away from the prying cameras - of the final stage as it hurtled toward Jupiter. Those were the ones that interested him most; even more useful were the cutaway drawings and estimates of performance.

Granted the most optimistic assumptions, it was difficult to see what the Chinese hoped to do. They must have burned up at least ninety per cent of their propellant in that mad dash across the Solar System. Unless it was literally a suicide mission - something that could not be ruled out - only a plan involving hibernation and later rescue made any sense. And Intelligence did not believe that Chinese hibernation technology was sufficiently far advanced to make that a viable option.

But Intelligence was frequently wrong, and even more often confused by the avalanche of raw facts it had to evaluate - the 'noise' in its information circuits. It had done a remarkable job on Tsien, considering the shortness of time, but Floyd wished that the material sent to him had been more carefully filtered. Some of it was obvious junk, of no possible connection with the mission.

Nevertheless, when you did not know what you were looking for, it was important to avoid all prejudices and preconceptions; something that at first sight seemed irrelevant, or even nonsensical, might turn out to be a vital clue.

With a sigh, Floyd started once more to skim the five hundred pages of data, keeping his mind as blankly receptive as possible while diagrams, charts, photographs - some so smudgy that they could represent almost anything - news items, lists of delegates to scientific conferences, titles of technical publications, and even commercial documents scrolled swiftly down the high-resolution screen. A very efficient industrial espionage system had obviously been extremely busy; who would have thought that so many Japanese holomemory modules or Swiss gas-flow microcontrollers or German radiation detectors could have been traced to a destination in the dried lake bed of Lop Nor - the first milepost on their way to Jupiter?

Some of the items must have been included by accident; they could not possibly relate to the mission. If the Chinese had placed a secret order for one thousand infrared sensors through a dummy corporation in Singapore,

that was only the concern of the military; it seemed highly unlikely that Tsien expected to be chased by heat-seeking missiles. And this one was really funny - specialized surveying and prospecting equipment from Glacier Geophysics, Inc., of Anchorage, Alaska. What lamebrain imagined that a deep-space expedition would have any need - the smile froze on Floyd's lips; he felt the skin crawl on the back of his neck. My God - they wouldn't dare! But they had already dared greatly; and now, at last, everything made sense.

He flashed back to the photos and conjectured plans of the Chinese ship. Yes, it was just conceivable - those flutings at the rear, alongside the drive deflection electrodes, would be about the right size.

Floyd called the bridge. 'Vasili.' he said, 'have you worked out their orbit yet?'

'Yes, I have,' the navigator replied, in a curiously subdued voice. Floyd could tell at once that something had turned up. He took a long shot.

'They're making a rendezvous with Europa, aren't they?'

There was an explosive gasp of disbelief from the other end.

'Chyort voz'mi! How did you know?'

'I didn't - I've just guessed it.'

'There can't be any mistake - I've checked the figures to six places. The braking manoeuvre worked out exactly as they intended. They're right on course for Europa - it couldn't have happened by chance. They'll be there in seventeen hours.'

'And go into orbit.'

'Perhaps; it wouldn't take much propellant. But what would be the point?'

'I'll risk another guess. They'll do a quick survey - and then they'll land.'

'You're crazy - or do you know something we don't?'

'No - it's just a matter of simple deduction. You're going to start kicking yourself for missing the obvious.'

'Okay, Sherlock, why should anyone want to land on Europa? What's there, for heaven's sake?'

Floyd was enjoying his little moment of triumph. Of course, he might still be completely wrong.

'What's on Europa? Only the most valuable substance in the Universe.'

He had overdone it; Vasili was no fool, and snatched the answer from his lips.

'Of course - water!'

'Exactly. Billions and billions of tons of it. Enough to fill up the propellant tanks - go cruising around all the satellites, and still have plenty left for the rendezvous with Discovery and the voyage home. I hate to say this, Vasili - but our Chinese friends have outsmarted us again.'

'Always assuming, of course, that they can get away with it.'

The Ice of the Grand Canal

Apart from the jet-black sky, the photo might have been taken almost anywhere in the polar regions of Earth; there was nothing in the least alien about the sea of wrinkled ice that stretched all the way out to the horizon. Only the five spacesuited figures in the foreground proclaimed that the panorama was of another world.

Even now, the secretive Chinese had not released the names of the crew. The anonymous intruders on the frozen European icescape were merely the chief scientist, the commander, the navigator, the first engineer, the second engineer. It was also ironic, Floyd could not help thinking, that everyone on Earth had seen the already historic photograph an hour before it reached Leonov, so much closer to the scene. But Tsien's transmissions were relayed on such a tight beam that it was impossible to intercept them; Leonov could receive only its beacon, broadcasting impartially in all directions. Even that was inaudible more than half the time, as Europa's rotation carried it out of sight, or the satellite itself was eclipsed by the monstrous bulk of Jupiter. All the scanty news of the Chinese mission had to be relayed from Earth.

The ship had touched down, after its initial survey, on one of the few islands of solid rock that protruded through the crust of ice covering virtually the entire moon. That ice was flat from pole to pole; there was no weather to carve it into strange shapes, no drifting snow to build up layer upon layer into slowly moving hills. Meteorites might fall upon airless Europa, but never a flake of snow. The only forces moulding its surface were the steady tug of gravity, reducing all elevations to one uniform level, and the incessant quakes caused by the other satellites as they passed and repassed Europa in their orbits. Jupiter itself, despite its far

greater mass, had much less effect. The Jovian tides had finished their work aeons ago, ensuring that Europa remained locked forever with one face turned toward its giant master.

All this had been known since the Voyager flyby missions of the 1970s, the Galileo surveys of the 1980s, and the Kepler landings of the 1990s. But, in a few hours, the Chinese had learned more about Europa than all the previous missions combined. That knowledge they were keeping to themselves; one might regret it, but few would deny that they had earned the right to do so.

What was being denied, with greater and greater asperity, was their right to annex the satellite. For the first time in history, a nation had laid claim to another world, and all the news media of Earth were arguing over the legal position. Though the Chinese pointed out, at tedious length, that they had never signed the '02 UN Space Treaty and so were not bound by its provisions, that did nothing to quell the angry protests.

Suddenly, Europa was the biggest news in the Solar System. And the man-on-the-spot (at least to the nearest few million kilometres) was in great demand.

'This is Heywood Floyd, aboard Cosmonaut Alexei Leonov, on course for Jupiter. But as you can well imagine, all our thoughts are now focused upon Europa.

'At this very moment I'm looking at it through the most powerful of the ship's telescopes; under this magnification, it's ten times larger than the Moon as you see it with the naked eye. And it's a really weird sight.

'The surface is a uniform pink, with a few small brown patches. It's covered with an intricate network of narrow lines, curling and weaving in

all directions. In fact, it looks very much like a photo from a medical textbook, showing a pattern of veins and arteries.

'A few of these features are hundreds - or even thousands - of kilometres long, and look rather like the illusory canals that Percival Lowell and other early-twentieth-century astronomers imagined they'd seen on Mars.

'But Europa's canals aren't an illusion, though of course they're not artificial. What's more, they do contain water -or at least ice. For the satellite is almost entirely covered by ocean, averaging fifty kilometres deep.

'Because it's so far from the sun, Europa's surface temperature is extremely low - about a hundred and fifty degrees below freezing. So one might expect its single ocean to be a solid block of ice.

'Surprisingly, that isn't the case because there's a lot of heat generated inside Europa by tidal forces - the same forces that drive the great volcanoes on neighbouring Io.

'So the ice is continually melting, breaking up, and freezing, forming cracks and lanes like those in the floating ice sheets in our own polar regions. It's that intricate tracery of cracks I'm seeing now; most of them are dark and very ancient - perhaps millions of years old. But a few are almost pure white; they're the new ones that have just opened up, and have a crust only a few centimetres thick.

'Tsien has landed right beside one of these white streaks -the fifteen-hundred-kilometre-long feature that's been christened the Grand Canal. Presumably the Chinese intend to pump its water into their propellant tanks, so that they can explore the Jovian satellite system and then return to Earth. That may not be easy, but they'll certainly have studied the landing site with great care, and must know what they're doing.

'It's obvious, now, why they've taken such a risk - and why they should claim Europa. As a refuelling point, it could be the key to the entire outer Solar System. Though there's also water on Ganymede, it's all frozen, and also less accessible because of that satellite's more powerful gravity.'

'And there's another point that's just occurred to me. Even if the Chinese do get stranded on Europa, they might be able to survive until a rescue mission is arranged. They have plenty of power, there may be useful minerals in the area - and we know that the Chinese are the experts on synthetic-food production. It wouldn't be a very luxurious life; but I have some friends who would accept it happily for that staggering view of Jupiter sprawled across the sky - the view we expect to see ourselves, in just a few days.'

'This is Heywood Floyd, saying goodbye for my colleagues and myself, aboard Alexei Leonov.'

'And this is the bridge. Very nice presentation, Heywood. You should have been a newsman.'

'I've had plenty of practice. Half my time was spent on PR work.'

'PR?'

'Public relations - usually telling politicians why they should give me more money. Something you don't have to bother about.'

'How I wish that was true. Anyway, come up to the bridge. There's some new information we'd like to discuss with you.'

Floyd removed his button microphone, locked the telescope into position and extricated himself from the tiny viewing blister. As he left, he almost collided with Nikolai Temovsky, obviously on a similar mission.

'I'm about to steal your best quotes for Radio Moscow, Woody. Hope you don't mind.'

'You're welcome, tovarishch. Anyway, how could I stop you?'

Up on the bridge, Captain Orlova was looking thoughtfully at a dense mass of words and figures on the main display. Floyd had painfully started to transliterate them when she interrupted him.

'Don't worry about the details. These are estimates of the time it will take for Tsien to refill its tanks and get ready for lift-off.'

'My people are doing the same calculations - but there are far too many variables.'

'We think we've removed one of them. Did you know that the very best water pumps you can buy belong to fire brigades? And would you be surprised to learn that the Beijing Central Station had four of its latest models suddenly requisitioned a few months ago, despite the protests of the mayor?'

'I'm not surprised - merely lost in admiration. Go on, please.'

'That may be a coincidence, but those pumps would be just the right size. Making educated guesses about pipe deployment, drilling through the ice and so on - well, we think they could lift off again in five days.'

'Five days!'

'If they're lucky, and everything works perfectly. And if they don't wait to fill their propellant tanks but merely take on just enough for a safe rendezvous with Discovery before we do. Even if they beat us by a single hour, that would be enough. They could claim salvage rights, at the very least.'

'Not according to the State Department's lawyers. At the appropriate moment, we'll declare that Discovery is not a derelict, but has merely been parked until we can retrieve it. Any attempt to take over the ship would be an act of piracy.'

'I'm sure the Chinese will be most impressed.'

'If they're not, what can we do about it?'

'We outnumber them - and two to one, when we revive Chandra and Curnow.'

'Are you serious? Where are the cutlasses for the boarding party?'

'Cutlasses?'

'Swords - weapons.'

'Oh. We could use the laser telespectrometer. That can vaporize milligram asteroid samples at ranges of a thousand kilometres.'

'I'm not sure that I like this conversation. My government certainly would not condone violence, except of course in self-defence.'

'You naive Americans! We're more realistic; we have to be. All your grandparents died of old age, Heywood. Three of mine were killed in the Great Patriotic War.'

When they were alone together, Tanya always called him Woody, never Heywood. She must be serious. Or was she merely testing his reactions?

'Anyway, Discovery is merely a few billion dollars' worth of hardware. The ship's not important - only the information it carries.'

'Exactly. Information that could be copied, and then erased.'

'You do get some cheerful ideas, Tanya. Sometimes I think that all Russians are a little paranoiac.'

'Thanks to Napoleon and Hitler, we've earned every right to be. But don't tell me that you haven't already worked out that - what do you call it, scenario? - for yourself.'

'It wasn't necessary,' Floyd answered rather glumly. 'The State Department's already done it for me - with variations. We'll just have to see which one the Chinese come up with. And I wouldn't be in the least surprised if they outguess us again.'

10

A Cry from Europa

Sleeping in zero gravity is a skill that has to be learned; it had taken Floyd almost a week to find the best way of anchoring legs and arms so that they did not drift into uncomfortable positions. Now he was an expert, and was not looking forward to the return of weight; indeed, the very idea gave him occasional nightmares.

Someone was shaking him awake. No - he must still be dreaming! Privacy was sacred aboard a spaceship; nobody ever entered another crew member's chambers without first asking permission. He clenched his eyes shut, but the shaking continued.

'Dr Floyd - please wake up! You're wanted on the flight deck!'

And nobody called him Dr Floyd; the most formal salutation he had received for weeks was Doc. What was happening?

Reluctantly, he opened his eyes. He was in his tiny cabin, gently gripped by his sleeping cocoon. So one part of his mind told him; then why was he looking at - Europa? They were still millions of kilometres away.

There were the familiar reticulations, the patterns of triangles and polygons formed by intersecting lines. And surely that was the Grand Canal itself - no, it wasn't quite right. How could it be, since he was still in his little cabin aboard Leonov?

'Dr Floyd!'

He became fully awake, and realized that his left hand was floating just a few centimetres in front of his eyes. How strange that the pattern of lines across the palm was so uncannily like the map of Europa! But economical Mother Nature was always repeating herself, on such vastly different scales as the swirl of milk stirred into coffee, the cloud lanes of a cyclonic storm, the arms of a spiral nebula.

'Sorry, Max,' he said. 'What's the problem? Is something wrong?'

'We think so - but not with us. Tsien's in trouble.'

Captain, navigator, and chief engineer were strapped in their seats on the flight deck; the rest of the crew orbited anxiously around convenient handholds, or watched on the monitors.

'Sorry to wake you up, Heywood,' Tanya apologized brusquely. 'Here's the situation. Ten minutes ago we had a Class One Priority from Mission Control. Tsien's gone off the air. It happened very suddenly, in the middle of a cipher message; there were a few seconds of garbled transmission - then nothing.'

'Their beacon?'

'That's stopped as well. We can't receive it either.'

'Phew! Then it must be serious - a major breakdown. Any theories?'

'Lots - but all guesswork. An explosion - landslide - earthquake: who knows?'

'And we may never know - until someone else lands on Europa - or we do a close flyby and take a look.'

Tanya shook her head. 'We don't have enough delta-vee. The closest we could get is fifty thousand kilometres. Not much you could see from that distance.'

'Then there's absolutely nothing we can do.'

'Not quite, Heywood. Mission Control has a suggestion. They'd like us to swing our big dish around, just in case we can pick up any weak emergency transmissions. It's - how do you say? - a long shot, but worth trying. What do you think?'

Floyd's first reaction was strongly negative.

'That will mean breaking our link with Earth.'

'Of course; but we'll have to do that anyway, when we go around Jupiter. And it will only take a couple of minutes to re-establish the circuit.'

Floyd remained silent. The suggestion was perfectly reasonable, yet it worried him obscurely. After puzzling for several seconds, he suddenly realized why he was so opposed to the idea.

Discovery's troubles had started when the big dish - the main antenna complex - had lost its lock on Earth, for reasons which even now were not completely clear. But Hal had certainly been involved, and there was no danger of a similar situation arising here. Leonov's computers were small, autonomous units; there was no single controlling intelligence. At least, no nonhuman one.

The Russians were still waiting patiently for his answer.

'I agree,' he said at last. 'Let Earth know what we're doing, and start listening. I suppose you'll try all the SPACE MAYDAY frequencies.'

'Yes, as soon as we've worked out the Doppler corrections. How's it going, Sasha?'

'Give me another two minutes, and I'll have the automatic search running. How long should we listen?'

The captain barely paused before giving her answer. Floyd had often admired Tanya Orlova's decisiveness, and had once told her so. In a rare flash of humour, she had replied: 'Woody, a commander can be wrong, but never uncertain.'

'Listen for fifty minutes, and report back to Earth for ten. Then repeat the cycle.'

There was nothing to see or hear; the automatic circuits were better at sifting the radio noise than any human senses. Nevertheless, from time to time Sasha turned up the audio monitor, and the roar of Jupiter's radiation belts filled the cabin. It was a sound like the waves breaking on all the beaches of Earth, with occasional explosive cracks from superbolts of lightning in the Jovian atmosphere. Of human signals, there was no trace; and, one by one, the members of the crew not on duty drifted quietly away.

While he was waiting, Floyd did some mental calculations. Whatever had happened to Tsien was already two hours in the past, since the news had been relayed from Earth.

But Leonov should be able to pick up a direct message after less than a minute's delay, so the Chinese had already had ample time to get back on the air. Their continued silence suggested some catastrophic failure, and he found himself weaving endless scenarios of disaster.

The fifty minutes seemed like hours. When they were up, Sasha swung the ship's antenna complex back toward Earth, and reported failure. While he was using the rest of the ten minutes to send a backlog of messages, he looked inquiringly at the captain.

'Is it worth trying again?' he said in a voice that clearly expressed his own pessimism.

'Of course. We may cut back the search time - but we'll keep listening.'

On the hour, the big dish was once more focused upon Europa. And almost at once, the automatic monitor started flashing its ALERT light.

Sasha's hand darted to the audio gain, and the voice of Jupiter filled the cabin. Superimposed upon that, like a whisper heard against a thunderstorm, was the faint but completely unmistakable sound of human speech. It was impossible to identify the language, though Floyd felt certain, from the intonation and rhythm, that it was not Chinese, but some European tongue.

Sasha played skilfully with fine-tuning and band-width controls, and the words became clearer. The language was undoubtedly English - but its content was still maddeningly unintelligible.

There is one combination of sounds that every human ear can detect instantly, even in the noisiest environment. When it suddenly emerged from the Jovian background, it seemed to Floyd that he could not possibly be awake, but was trapped in some fantastic dream. His colleagues took a little longer to react; then they stared at him with equal amazement - and a slowly dawning suspicion.

- For the first recognizable words from Europa were: 'Dr Floyd - Dr Floyd - I hope you can hear me.'

11

Ice and Vacuum

'Who is it?' whispered someone, to a chorus of shushes. Floyd raised his hands in a gesture of ignorance - and, he hoped, innocence.

'... know you are aboard Leonov... may not have much time... aiming my suit antenna where I think...' The signal vanished for agonizing seconds, then came back much clearer, though not appreciably louder.

'... relay this information to Earth. Tsien destroyed three hours ago. I'm only survivor. Using my suit radio - no idea if it has enough range, but it's the only chance. Please listen carefully. **THERE IS LIFE ON EUROPA.** I repeat: **THERE IS LIFE ON EUROPA.**'

The signal faded again. A stunned silence followed that no one attempted to interrupt. While he was waiting, Floyd searched his memory furiously. He could not recognize the voice - it might have been that of any Western-educated Chinese. Probably it was someone he had met at a

scientific conference, but unless the speaker identified himself he would never know.

'... soon after local midnight. We were pumping steadily and the tanks were almost half full. Dr Lee and I went out to check the pipe insulation. Tsien stands - stood - about thirty metres from the edge of the Grand Canal. Pipes go directly from it and down through the ice. Very thin - not safe to walk on. The warm upwelling...'

Again a long silence. Floyd wondered if the speaker was moving, and had been momentarily cut off by some obstruction.

'... no problem - five kilowatts of lighting strung up on the ship. Like a Christmas tree - beautiful, shining right through the ice. Glorious colours. Lee saw it first - a huge dark mass rising up from the depths. At first we thought it was a school of fish - too large for a single organism - then it started to break through the ice.

'Dr Floyd, I hope you can hear me. This is Professor Chang - we met in '02 - Boston IAU conference.'

Instantly, incongruously, Floyd's thoughts were a billion kilometres away. He vaguely remembered that reception, after the closing session of the International Astronomical Union Congress - the last one that the Chinese had attended before the Second Cultural Revolution. And now he recalled Chang very distinctly - a small, humorous astronomer and exobiologist with a good fund of jokes. He wasn't joking now.

'... like huge strands of wet seaweed, crawling along the ground. Lee ran back to the ship to get a camera - I stayed to watch, reporting over the radio. The thing moved so slowly I could easily outrun it. I was much more excited than alarmed. Thought I knew what kind of creature it was - I've seen pictures of the kelp forests off California - but I was quite wrong.

'I could tell it was in trouble. It couldn't possibly survive at a temperature a hundred and fifty below its normal environment. It was freezing solid as it moved forward - bits were breaking off like glass - but it was still advancing toward the ship, a black tidal wave, slowing down all the time.

'I was still so surprised that I couldn't think straight and I couldn't imagine what it was trying to do...'

'Is there any way we can call him back?' Floyd whispered urgently.

'No - it's too late. Europa will soon be behind Jupiter. We'll have to wait until it comes out of eclipse.'

'... climbing up the ship, building a kind of ice tunnel as it advanced. Perhaps this was insulating it from the cold - the way termites protect themselves from the sunlight with their little corridors of mud.

'... tons of ice on the ship. The radio antennas broke off first. Then I could see the landing legs beginning to buckle - all in slow motion, like a dream.

'Not until the ship started to topple did I realize what the thing was trying to do - and then it was too late. We could have saved ourselves - if we'd only switched off those lights.

'Perhaps it's a phototrope, its biological cycle triggered by the sunlight that filters through the ice, Or it could have been attracted like a moth to a candle. Our floodlights must have been more brilliant than anything that Europa has ever known.

'Then the ship crashed. I saw the hull split, a cloud of snowflakes form as moisture condensed. All the lights went out, except for one, swinging back and forth on a cable a couple of metres above the ground.

'I don't know what happened immediately after that. The next thing I remember, I was standing under the light, beside the wreck of the ship, with a fine powdering of fresh snow all around me. I could see my footsteps in it very clearly. I must have run there; perhaps only a minute or two had elapsed.

'The plant - I still thought of it as a plant - was motionless. I wondered if it had been damaged by the impact; large sections - as thick as a man's arm - had splintered off, like broken twigs.

'Then the main trunk started to move again. It pulled away from the hull, and began to crawl toward me. That was when I knew for certain that the thing was light-sensitive: I was standing immediately under the thousand watt lamp, which had stopped swinging now.

'Imagine an oak tree - better still, a banyan with its multiple trunks and roots - flattened out by gravity and trying to creep along the ground. It got to within five metres of the light, then started to spread out until it had made a perfect circle around me. Presumably that was the limit of its tolerance - the point at which photo-attraction turned to repulsion. After that, nothing happened for several minutes. I wondered if it was dead - frozen solid at last.

'Then I saw that large buds were forming on many of the branches. It was like watching a time-lapse film of flowers opening. In fact I thought they were flowers - each about as big as a man's head.

'Delicate, beautifully coloured membranes started to unfold. Even then, it occurred to me that no one - no thing - could ever have seen these colours before; they had no existence until we brought our lights - our fatal lights - to this world.

'Tendrils, stamens, waving feebly... I walked over to the living wall that surrounded me, so that I could see exactly what was happening. Neither

then, nor at any other time, had I felt the slightest fear of the creature. I was certain that it was not malevolent - if indeed it was conscious at all.

'There were scores of the big flowers, in various stages of unfolding. Now they reminded me of butterflies, just emerging from the chrysalis - wings crumpled, still feeble - I was getting closer and closer to the truth.

'But they were freezing - dying as quickly as they formed. Then, one after another, they dropped off from the parent buds. For a few moments they flopped around like fish stranded on dry land - at last I realized exactly what they were. Those membranes weren't petals - they were fins, or their equivalent. This was the free-swimming, larval stage of the creature. Probably it spends much of its life rooted on the seabed, then sends these mobile offspring in search of new territory. Just like the corals of Earth's oceans.

'I knelt down to get a closer look at one of the little creatures. The beautiful colours were fading now to a drab brown. Some of the petal-fins had snapped off, becoming brittle shards as they froze. But it was still moving feebly, and as I approached it tried to avoid me. I wondered how it sensed my presence.

'Then I noticed that the stamens - as I'd called them - all carried bright blue dots at their tips. They looked like tiny star sapphires - or the blue eyes along the mantle of a scallop - aware of light, but unable to form true images. As I watched, the vivid blue faded, the sapphires became dull, ordinary stones.

'Dr Floyd - or anyone else, who is listening - I haven't much more time; Jupiter will soon block my signal. But I've almost finished.

'I knew then what I had to do. The cable to that thousand watt lamp was hanging almost to the ground. I gave it a few tugs, and the light went out in a shower of sparks.

'I wondered if it was too late. For a few minutes, nothing happened. So I walked over to the wall of tangled branches around me, and kicked it.

'Slowly, the creature started to unweave itself, and to retreat back to the Canal. There was plenty of light - I could see everything perfectly. Ganymede and Callisto were in the sky - Jupiter was a huge, thin crescent - and there was a big auroral display on the nightside, at the Jovian end of the Io flux tube. There was no need to use my helmet light.

'I followed the creature all the way back to the water, encouraging it with more kicks when it slowed down, feeling the fragments of ice crunching all the time beneath my boots... as it neared the Canal, it seemed to gain strength and energy, as if it knew that it was approaching its natural home. I wondered if it would survive, to bud again.

'It disappeared through the surface, leaving a few last dead larvae on the alien land. The exposed free water bubbled for a few minutes until a scab of protective ice sealed it from the vacuum above. Then I walked back to the ship to see if there was anything to salvage - I don't want to talk about that.

'I've only two requests to make, Doctor. When the taxonomists classify this creature, I hope they'll name it after me.

'And - when the next ship comes home - ask them to take our bones back to China.

'Jupiter will be cutting us off in a few minutes. I wish I knew whether anyone was receiving me. Anyway, I'll repeat this message when we're in line of sight again - if my suit's life-support system lasts that long.

'This is Professor Chang on Europa, reporting the destruction of spaceship Tsien. We landed beside the Grand Canal and set up our pumps at the edge of the ice -,

The signal faded abruptly, came back for a moment, then disappeared completely below the noise level. Although Leonov listened again on the same frequency, there was no further message from Professor Chang.



DISCOVERY

Downhill Run

The ship was gaining speed at last, on the downhill run toward Jupiter. It had long since passed the gravitational no-man's-land where the four tiny outer moons - Sinope, Pasiphae, Ananke, and Carme - wobbled along their retrograde and wildly eccentric orbits. Undoubtedly captured asteroids, and completely irregular in shape, the largest was only thirty kilometres across. Jagged, splintered rocks of no interest to anyone except planetary geologists, their allegiance wavered continually between the Sun and Jupiter. One day, the Sun would recapture them completely.

But Jupiter might retain the second group of four, at half the distance of the others. Elara, Lysithea, Himalia, and Leda were fairly close together, and lying in almost the same plane. There was speculation that they had once been part of a single body; if so, the parent would have been barely a hundred kilometres across.

Though only Carme and Leda came close enough to show disks visible to the naked eye, they were greeted like old friends. Here was the first landfall after the longest ocean voyage - the offshore islands of Jupiter. The last hours were ticking away; the most critical phase of the entire mission was approaching - the entry into the Jovian atmosphere.

Jupiter was already larger than the Moon in the skies of Earth, and the giant inner satellites could be clearly seen moving around it. They all showed noticeable disks and distinctive colouring, though they were still too far away for any markings to be visible. The eternal ballet they performed - disappearing behind Jupiter, reappearing to transit the

daylight face with their accompanying shadows - was an endlessly engaging spectacle. It was one that astronomers had watched ever since Galileo had first glimpsed it almost exactly four centuries ago; but the crew of Leonov were the only living men and women to have seen it with unaided eyes.

The interminable chess games had ceased; off-duty hours were spent at the telescopes, or in earnest conversation, or listening to music, usually while gazing at the view outside. And at least one shipboard romance had reached a culmination: the frequent disappearances of Max Brailovsky and Zenia Marchenko were the subject of much good-natured banter.

They were, thought Floyd, an oddly matched pair. Max was a big, handsome blond who had been a champion gymnast, reaching the finals of the 2000 Olympics. Though he was in his early thirties, he had an open-faced, almost boyish expression. This was not altogether misleading; despite his brilliant engineering record, he often struck Floyd as naive and unsophisticated - one of those people who are pleasant to talk to, but not for too long. Outside his own field of undoubted expertise he was engaging but rather shallow.

Zenia - at twenty-nine, the youngest on board - was still something of a mystery. Since no one wished to talk about it, Floyd had never raised the subject of her injuries, and his Washington sources could provide no information. Obviously she had been involved in some serious accident, but it might have been nothing more unusual than a car crash. The theory that she had been on a secret space mission - still part of popular mythology outside the USSR - could be ruled out. Thanks to the global tracking networks, no such thing had been possible for fifty years.

In addition to her physical and doubtless psychological scars, Zenia laboured under yet another handicap. She was a last-minute replacement, and everyone knew it. Irma Yakunina was to have been dietician and medical assistant aboard Leonov before that unfortunate argument with a hang-glider broke too many bones.

Every day at 1800 GMT the crew of seven plus one passenger gathered in the tiny common room that separated the flight deck from the galley and sleeping quarters. The circular table at its centre was just big enough for eight people to squeeze around; when Chandra and Curnow were revived, it would be unable to accommodate everyone, and two extra seats would have to be fitted in somewhere else.

Though the 'Six O'Clock Soviet', as the daily round-table conference was called, seldom lasted more than ten minutes, it played a vital role in maintaining morale. Complaints, suggestions, criticisms, progress reports - anything could be raised, subject only to the captain's overriding veto, which was very seldom exercised.

Typical items on the non-existent agenda were requests for changes in the menu, appeals for more private communication time with Earth, suggested movie programmes, exchange of news and gossip, and good-natured needling of the heavily-outnumbered American contingent. Things would change, Floyd warned them, when his colleagues came out of hibernation, and the odds improved from I in 7 to 3 in 9. He did not mention his private belief that Curnow could outtalk or outshout any three other people aboard.

When he was not sleeping, much of Floyd's own time was spent in the common room - partly because, despite its smallness, it was much less claustrophobic than his own tiny cubicle. It was also cheerfully decorated, all available flat surfaces being covered with photos of beautiful land and seascapes, sporting events, portraits of popular videostars, and other reminders of Earth. Pride of place, however, was given to an original Leonov painting - his 1965 study 'Beyond the Moon', made in the same year when, as a young lieutenant-colonel, he left Voskhod II and became the first man in history to perform an extravehicular excursions

Clearly the work of a talented amateur, rather than a professional, it showed the cratered edge of the Moon with the beautiful Sinus Iridum -

Bay of Rainbows - in the foreground. Looming monstrously above the lunar horizon was the thin crescent of Earth, embracing the darkened nightside of the planet. Beyond that blazed the Sun, the streamers of the corona reaching out into space for millions of kilometres around it.

It was a striking composition - and a glimpse of the future that even then lay only three years ahead. On the flight of Apollo 8, Anders, Borman and Lovell were to see this splendid sight with their unaided eyes, as they watched Earth rise above the farside on Christmas Day, 1968.

Heywood Floyd admired the painting, but he also regarded it with mixed feelings. He could not forget that it was older than everybody else on the ship - with one exception.

He was already nine years old when Alexei Leonov had painted it.

13

The Worlds of Galileo

Even now, more than three decades after the revelations of the first Voyager flybys, no one really understood why the four giant satellites differed so wildly from one another. They were all about the same size, and in the same part of the Solar System - yet they were totally dissimilar, as if children of a different birth.

Only Callisto, the outermost, had turned out to be much as expected. When Leonov raced past at a distance of just over 100,000 kilometres, the larger of its countless craters were clearly visible to the naked eye. Through the telescope, the satellite looked like a glass ball that had been used as a target by high-powered rifles; it was completely covered with

craters of every size, right down to the lower limit of visibility. Callisto, someone had once remarked, looked more like Earth's Moon than did the Moon itself.

Nor was this particularly surprising. One would have expected a world out here - at the edge of the asteroid belt - to have been bombarded with the debris left over from the creation of the Solar System. Yet Ganymede, the satellite next door, had a totally different appearance. Though it had been well peppered with impact craters in the remote past, most of them had been ploughed over - a phrase that seemed peculiarly appropriate. Huge areas of Ganymede were covered with ridges and furrows, as if some cosmic gardener had dragged a giant rake across them. And there were light-coloured streaks, like trails that might have been made by slugs fifty kilometres across. Most mysterious of all were long, meandering bands, containing dozens of parallel lines. It was Nikolai Ternovsky who decided what they must be - multilane superhighways, laid out by drunken surveyors. He even claimed to have detected over-passes and cloverleaf intersections.

Leonov had added some trillions of bits of information about Ganymede to the store of human knowledge, before it crossed the orbit of Europa. That icebound world, with its derelict and its dead, was on the other side of Jupiter, but it was never far from anyone's thoughts.

Back on Earth, Dr Chang was already a hero and his countrymen had, with obvious embarrassment, acknowledged countless messages of sympathy. One had been sent in the name of Leonov's crew - after, Floyd gathered, considerable redrafting in Moscow. The feeling on board the ship was ambiguous - a mixture of admiration, regret, and relief. All astronauts, irrespective of their national origins, regarded themselves as citizens of space and felt a common bond, sharing each other's triumphs and tragedies. No one on Leonov was happy because the Chinese expedition had met with disaster; yet at the same time, there was a muted sense of relief that the race had not gone to the swiftest.

The unexpected discovery of life on Europa had added a new element to the situation - one that was now being argued at great length both on Earth and aboard Leonov. Some exobiologists cried 'I told you so!', pointing out that it should not have been such a surprise after all. As far back as the 1970s, research submarines had found teeming colonies of strange marine creatures thriving precariously in an environment thought to be equally hostile to life - the trenches on the bed of the Pacific. Volcanic springs, fertilizing and warming the abyss, had created oases of life in the deserts of the deep.

Anything that had happened once on Earth should be expected millions of times elsewhere in the Universe; that was almost an article of faith among scientists. Water - or at least ice - occurred on all the moons of Jupiter. And there were continuously erupting volcanoes on Io - so it was reasonable to expect weaker activity on the world next door. Putting these two facts together made European life seem not only possible, but inevitable - as most of nature's surprises are, when viewed with 20/20 hindsight.

Yet that conclusion raised another question, and one vital to Leonov's mission. Now that life had been discovered on the moons of Jupiter - did it have any connection with the Tycho monolith, and the still more mysterious artifact in orbit near Io?

That was a favourite subject to debate in the Six O'Clock Soviets. It was generally agreed that the creature encountered by Dr Chang did not represent a high form of intelligence - at least, if his interpretation of its behaviour was correct. No animal with even elementary powers of reasoning would have allowed itself to become a victim of its instincts, attracted like a moth to the candle until it risked destruction.

Vasili Orlov was quick to give a counter-example that weakened, if it did not refute, that argument.

'Look at whales and dolphins,' he said. 'We call them intelligent - but how often they kill themselves in mass strandings! That looks like a case where instinct overpowers reason.'

'No need to go to the dolphins,' interjected Max Brailovsky. 'One of the brightest engineers in my class was fatally attracted to a blonde in Kiev. When I heard of him last, he was working in a garage. And he'd won a gold medal for designing spacestations. What a waste!'

Even if Dr Chang's European was intelligent, that of course did not rule out higher forms elsewhere. The biology of a whole world could not be judged from a single specimen.

But it had been widely argued that advanced intelligence could never arise in the sea; there were not enough challenges in so benign and unvarying an environment. Above all, how could marine creatures ever develop a technology without the aid of fire?

Yet perhaps even that was possible; the route that humanity had taken was not the only one. There might be whole civilizations in the seas of other worlds.

Still, it seemed unlikely that a space-faring culture could have arisen on Europa without leaving unmistakable signs of its existence in the form of buildings, scientific installations, launching sites, or other artifacts. But from pole to pole, nothing could be seen but level ice and a few outcroppings of bare rock.

No time remained for speculations and discussions when Leonov hurtled past the orbits of Io and tiny Mimas. The crew was busy almost non-stop, preparing for the encounter and the brief onset of weight after months in free-fall. All loose objects had to be secured before the ship entered Jupiter's atmosphere, and the drag of deceleration produced momentary peaks that might be as high as two gravities.

Floyd was lucky; he alone had time to admire the superb spectacle of the approaching planet, now filling almost half the sky. Because there was nothing to give it scale, there was no way that the mind could grasp its real size. He had to keep telling himself that fifty Earths would not cover the hemisphere now turned toward him.

The clouds, colourful as the most garish sunset on Earth, raced so swiftly that he could see appreciable movement in as little as ten minutes. Great eddies were continually forming along the dozen or so bands that girdled the planet, then rippling away like swirls of smoke. Plumes of white gas occasionally geysered up from the depths, to be swept away by the gales caused by the planet's tremendous spin. And perhaps strangest of all were the white spots, sometimes spaced as regularly as pearls on a necklace, which lay along the tradewinds of the middle Jovian latitudes.

In the hours immediately before encounter, Floyd saw little of captain or navigator. The Orlovs scarcely left the bridge, as they continually checked the approach orbit and made minute refinements to Leonov's course. The ship was now on the critical path that would just graze the outer atmosphere; if it went too high, frictional braking would not be sufficient to slow it down, and it would go racing out of the Solar System, beyond all possibility of rescue. If it went too low, it would burn up like a meteor. Between the two extremes lay little margin for error.

The Chinese had proved that aerobraking could be done, but there was always the chance that something would go wrong: So Floyd was not at all surprised when Surgeon-Commander Rudenko admitted, just an hour before contact: 'I'm beginning to wish, Woody, that I had brought along that icon, after all.'

Double Encounter

'... papers for the mortgage on the Nantucket house should be in the file marked M in the library.

'Well, that's all the business I can think of. For the last couple of hours I've been recalling a picture I saw as a boy, in a tattered volume of Victorian art - it must have been almost one hundred and fifty years old. I can't remember whether it was black-and-white or colour. But I'll never forget the title - don't laugh - it was called "The Last Message Home". Our great-great-grandfathers loved that kind of sentimental melodrama.

'It shows the deck of a windjammer in a hurricane - the sails have been ripped away and the deck's awash. In the background, the crew is struggling to save the ship. And in the foreground, a young sailor boy's writing a note, while beside him is the bottle he hopes will carry it to land.

'Even though I was a kid at the time, I felt he should have been giving his shipmates a hand, not writing letters. All the same, it moved me: I never thought that one day I'd be like that young sailor.

'Of course, I'm sure you'll get this message-and there's nothing I can do to help aboard Leonov. In fact, I've been politely requested to keep out of the way, so my conscience is quite clear as I dictate this.

'I'll send it up to the bridge now because in fifteen minutes we'll break transmission as we pull in the big dish and batten down the hatches - there's another nice maritime analogy for you! Jupiter's filling the sky now - I won't attempt to describe it and won't even see it much longer because

the shutters will go up in a few minutes. Anyway, the cameras can do far better than I could.

'Goodbye, my dearest, and my love to you all - especially Chris. By the time you get this, it will be over, one way or the other. Remember I tried to do my best for all our sakes - goodbye.'

When he had removed the audio chip, Floyd drifted up to the communications centre and handed it over to Sasha Kovalev.

'Please make sure it gets off before we close down,' he said earnestly.

'Don't worry,' promised Sasha. 'I'm still working on all channels, and we have a good ten minutes left.'

He held out his hand. 'If we do meet again, why, we shall smile! If not, why then, this parting was well made.' Floyd blinked.

'Shakespeare, I suppose?'

'Of course; Brutus and Cassius before battle. See you later.'

Tanya and Vasili were too intent upon their situation displays to do more than wave to Floyd, and he retreated to his cabin. He had already said farewell to the rest of the crew; there was nothing to do but wait. His sleeping bag was slung in preparation for the return of gravity when deceleration commenced, and he had only to climb into it - 'Antennas retracted, all protective shields up,' said the intercom speaker. 'We should feel first braking in five minutes. Everything normal.'

'That's hardly the word I'd use,' Floyd muttered to himself. 'I think you mean "nominal".' He had barely concluded the thought when there was a diffident knock on the door.

'Kto tam?'

To his astonishment, it was Zenia.

'Do you mind if I come in?' she asked awkwardly, in a small-girl voice which Floyd could scarcely recognize.

'Of course not. But why aren't you in your own cubicle? It's only five minutes to re-entry.'

Even as he asked the question, he was aware of its foolishness. The answer was so perfectly obvious that Zenia did not deign to reply.

But Zenia was the very last person he would have expected: her attitude toward him had invariably been polite but distant. Indeed, she was the only member of the crew who preferred to call him Dr Floyd. Yet there she was, clearly seeking comfort and companionship at the moment of peril.

'Zenia, my dear,' he said wryly. 'You're welcome. But my accommodation is somewhat limited. One might even call it Spartan.'

She managed a faint smile, but said nothing as she floated into the room. For the first time, Floyd realized that she was not merely nervous - she was terrified. Then he understood why she had come to him. She was ashamed to face her countrymen and was looking for support elsewhere.

With this realization, his pleasure at the unexpected encounter abated somewhat. That did not lessen his responsibility to another lonely human being, a long way from home. The fact that she was an attractive - though certainly not beautiful - woman of barely half his own age should not have affected the issue. But it did; he was beginning to rise to the occasion.

She must have noticed, but did nothing to encourage or discourage him as they lay down side by side in the sleeping cocoon. There was just enough room for them both, and Floyd began to do some anxious

calculations. Suppose maximum gee was higher than predicted, and the suspension gave way? They could easily be killed...

There was an ample safety margin; no need to worry about such an ignominious end. Humour was the enemy of desire; their embrace was now completely chaste. He was not sure whether to be glad or sorry.

And it was too late for second thoughts. From far, far away came the first faint whisper of sound, like the wailing of some lost soul. At the same moment, the ship gave a barely perceptible jerk; the cocoon began to swing around and its suspension tightened. After weeks of weightlessness, gravity was returning.

Within seconds, the faint wail had risen to a steady roar, and the cocoon had become an overloaded hammock. This is not such a good idea, Floyd thought to himself, already it was difficult to breathe. The deceleration was only a part of the problem: Zenia was clutching him as a drowning person is supposed to clutch the proverbial straw.

He detached her as gently as he could.

'It's all right, Zenia. If Tsien did it, so can we. Relax - don't worry.'

It was difficult to shout tenderly, and he was not even sure if Zenia heard him above the roar of incandescent hydrogen. But she was no longer clutching him quite so desperately, and he seized the opportunity of taking a few deep breaths.

What would Caroline think if she could see him now? Would he tell her if he ever had the chance? He was not sure she would understand. At a moment like that, all links with Earth seemed very tenuous indeed.

It was impossible to move, or to speak, but now that he had grown accustomed to the strange sense of weight he was no longer uncomfortable - except for the increasing numbness in his right arm. With some

difficulty, he managed to extricate it from beneath Zenia; the familiar act brought a fleeting sense of guilt. As he felt his circulation returning, Floyd remembered a famous remark attributed to at least a dozen astronauts and cosmonauts: 'Both the pleasures and problems of zero-gravity sex have been greatly exaggerated.'

He wondered how the rest of the crew was faring, and he gave a momentary thought to Chandra and Curnow, sleeping peacefully through it all. They would never know if Leonov became a meteor shower in the Jovian sky. He did not envy them; they had missed the experience of a lifetime.

Tanya was speaking over the intercom; her words were lost in the roar, but her voice sounded calm and perfectly normal, just as if she was making a routine announcement. Floyd managed to glance at his watch, and was astonished to see that they were already at the midpoint of the braking manoeuvre. At that very moment, Leonov was at its closest approach to Jupiter; only expendable automatic probes had gone deeper into the Jovian atmosphere.

'Halfway through, Zenia,' he shouted. 'On the way out again.' He could not tell if she understood. Her eyes were tightly closed, but she smiled slightly.

The ship was now rocking noticeably, like a small boat in a choppy sea. Was that normal? wondered Floyd. He was glad that he had Zenia to worry about; it took his mind away from his own fears. Just for a moment, before he managed to expel the thought, he had a vision of the walls suddenly glowing cherry red, and caving in upon him. Like the nightmare fantasy of Edgar Allan Poe's 'The Pit and the Pendulum', which he'd forgotten for thirty years.

But that would never happen. If the heat shield failed, the ship would crumble instantly, hammered flat by a solid wall of gas. There would be no pain; his nervous system would not have time to react before it ceased

to exist. He had experienced more consoling thoughts, but this one was not to be despised.

The buffeting slowly weakened. There was another inaudible announcement from Tanya (he would pull her leg about that, when it was all over). Now time seemed to be going much more slowly; after a while he stopped looking at his watch, because he could not believe it. The digits changed so slowly that he could almost imagine himself in some Einsteinian time dilation.

And then something even more unbelievable happened. First he was amused, then slightly indignant. Zenia had fallen asleep - if not exactly in his arms, then at least beside them.

It was a natural reaction: the strain must have exhausted her, and the wisdom of the body had come to her rescue. And suddenly Floyd himself became aware of an almost post-orgasmic drowsiness, as if he too had been emotionally drained by the encounter. He had to fight to remain awake.

And then he was falling... falling... falling... it was all over. The ship was back in space, where it belonged. And he and Zenia were floating apart.

They would never again be so close together, but they would always know a special tenderness toward each other, which no one else could ever share.

Escape from the Giant

When Floyd reached the observation deck - a discreet few minutes after Zenia - Jupiter already seemed farther away. But that must be an illusion based on his knowledge, not the evidence of his eyes. They had barely emerged from the Jovian atmosphere, and the planet still filled half the sky.

And now they were - as intended - its prisoners. During the last incandescent hour, they had deliberately jettisoned the excess speed that could have carried them right out of the Solar System, and on to the stars. Now they were travelling in an ellipse - a classical Hohmann orbit - which would shuttle them back between Jupiter and the orbit of Io, 350,000 kilometres higher. If they did not - or could not - fire their motors again, Leonov would swing back and forth between these limits, completing one revolution every nineteen hours. It would become the closest of Jupiter's moons - though not for long. Each time it grazed the atmosphere it would lose altitude, until it spiralled into destruction.

Floyd had never really enjoyed vodka, but he joined the others without any reservations in drinking a triumphant toast to the ship's designers, coupled with a vote of thanks to Sir Isaac Newton. Then Tanya put the bottle firmly back in its cupboard; there was still much to be done.

Though they were all expecting it, everyone jumped at the sudden muffled thud of explosive charges, and the jolt of separation. A few seconds later, a large, still-glowing disk floated into view, slowly turning end-over-end as it drifted away from the ship.

'Look!' cried Max. 'A flying saucer! Who's got a camera?' There was a distinct note of hysterical relief in the laughter that followed. It was interrupted by the captain, in a more serious vein.

'Goodbye, faithful heat shield! You did a wonderful job.'

'But what a waste!' said Sasha. 'There's at least a couple of tons left, Think of all the extra payload we could have carried!'

'If that's good, conservative Russian engineering,' retorted Floyd, 'then I'm all for it. Far better a few tons too much - than one milligram too little.'

Everyone applauded those noble sentiments as the jetted shield cooled to yellow, then red, and finally became as black as the space around it. It vanished from sight while only a few kilometres away, though occasionally the sudden reappearance of an eclipsed star would betray its presence.

'Preliminary orbit check completed,' said Vasili. 'We're within ten metres a second of our right vector. Not bad for a first try.'

There was a subdued sigh of relief at the news, and a few minutes later Vasili made another announcement.

'Changing attitude for course correction; delta vee six metres a second. Twenty-second burn coming up in one minute.'

They were still so close to Jupiter it was impossible to believe that the ship was orbiting the planet; they might have been in a high-flying aircraft that had just emerged from a sea of clouds. There was no sense of scale; it was easy to imagine that they were speeding away from some terrestrial sunset; the reds and pinks and crimsons sliding below were so familiar.

And that was an illusion; nothing here had any parallels with Earth. Those colours were intrinsic, not borrowed from the setting sun. The very

gases were utterly alien - methane and ammonia and a witch's brew of hydrocarbons, stirred in a hydrogen-helium cauldron. Not one trace of free oxygen, the breath of human life.

The clouds marched from horizon to horizon in parallel rows, distorted by occasional swirls and eddies. Here and there upwellings of brighter gas broke the pattern, and Floyd could also see the dark rim of a great whirlpool, a maelstrom of gas leading down into unfathomable Jovian depths.

He began to look for the Great Red Spot, then quickly checked himself at such a foolish thought. All the enormous cloudscape he could see below would be only a few per cent of the Red Spot's immensity; one might as well expect to recognize the shape of the United States from a small aeroplane flying low above Kansas.

'Correction completed. We're now on interception orbit with Io. Arrival time: eight hours, fifty-five minutes.'

Less than nine hours to climb up from Jupiter and meet whatever is waiting for us, thought Floyd. We've escaped from the giant - but he represents a danger we understood, and could prepare for. What lies ahead now is utter mystery.

And when we have survived that challenge, we must return to Jupiter once again. We shall need his strength to send us safely home.

Private Line

'... Hello, Dimitri. This is Woody, switching to Key Two in fifteen seconds... Hello, Dimitri - multiply Keys Three and Four, take cube root, add pi squared and use nearest integer as Key Five. Unless your computers are a million times faster than ours - and I'm damn sure they're not - no one can decrypt this, on your side or mine. But you may have some explaining to do; anyway, you're good at that.

'By the way, my usual excellent sources told me about the failure of the latest attempt to persuade old Andrei to resign; I gather that your delegation had no more luck than the others, and you're still saddled with him as President. I'm laughing my head off; it serves the Academy right. I know he's over ninety, and growing a bit - well, stubborn. But you won't get any help from me, even though I'm the world's - sorry, Solar System's - leading expert on the painless removal of elderly scientists.

'Would you believe that I'm still slightly drunk? We felt we deserved a little party, once we'd successfully rendez - rendezvous, damn, rendezvoused with Discovery. Besides, we had two new crew members to welcome aboard. Chandra doesn't believe in alcohol - it makes you too human - but Walter Curnow more than made up for him, Only Tanya remained stone-cold sober, just as you'd expect.

'My fellow Americans - I sound like a politician, God help me - came out of hibernation without any problems, and are both looking forward to starting work. We'll all have to move quickly; not only is time running out, but Discovery seems to be in very bad shape. We could hardly believe our eyes when we saw how its spotless white hull had turned a sickly yellow.

'Io's to blame, of course. The ship's spiralled down to within three thousand kilometres, and every few days one of the volcanoes blasts a few megatons of sulphur up into the sky. Even though you've seen the movies, you can't really imagine what it's like to hang above that inferno; I'll be glad when we can get away, even though we'll be heading for something much more mysterious - and perhaps far more dangerous.

'I flew over Kilauea during the '06 eruption; that was mighty scary, but it was nothing - nothing - compared to this. At the moment, we're over the nightside, and that makes it worse. You can see just enough to imagine a lot more. It's as close to Hell as I ever want to get.

'Some of the sulphur lakes are hot enough to glow, but most of the light comes from electrical discharges. Every few minutes the whole landscape seems to explode, as if a giant photoflash has gone off above it. And that's probably not a bad analogy; there are millions of amps flowing in the flux-tube linking Io and Jupiter, and every so often there's a breakdown. Then you get the biggest lightning flash in the Solar System, and half our circuit-breakers jump out in sympathy.

'There's just been an eruption right on the terminator, and I can see a huge cloud expanding up toward us, climbing into the sunlight. I doubt if it will reach our altitude, and even if it does it will be harmless by the time it gets here. But it looks ominous - a space monster, trying to devour us.

'Soon after we got here, I realized that Io reminded me of something; it took me a couple of days to work it out, and then I had to check with Mission Archives because the ship's library couldn't help - shame on it. Do you remember how I introduced you to *The Lord of the Rings*, when we were kids back at that Oxford conference? Well, Io is Mordor: look up Part Three. There's a passage about "rivers of molten rock that wound their way... until they cooled and lay like twisted dragon-shapes vomited from the tormented earth." That's a perfect description: how did Tolkien know,

a quarter century before anyone ever saw a picture of Io? Talk about Nature imitating Art.

'At least we won't have to land there: I don't think that even our late Chinese colleagues would have attempted that. But perhaps one day it may be possible; there are areas that seem fairly stable, and not continually inundated by sulphur floods.

'Who would have believed that we'd come all the way to Jupiter, greatest of planets - and then ignore it. Yet that's what we're doing most of the time; and when we're not looking at Io or Discovery, we're thinking about the Artifact.

'It's still ten thousand kilometres away, up there at the libration point, but when I look at it through the main telescope it seems close enough to touch. Because it's so completely featureless, there's no indication of size, no way the eye can judge it's really a couple of kilometres long. If it's solid, it must weigh billions of tons.

'But is it solid? It gives almost no radar echo, even when it's square-on to us. We can see it only as a black silhouette against the clouds of Jupiter, three hundred thousand kilometres below. Apart from its size, it looks exactly like the monolith we dug up on the Moon.

'Well, tomorrow we'll go aboard Discovery, and I don't know when I'll have time or opportunity to speak to you again. But there's one more thing, old friend, before I sign off.

'It's Caroline. She's never really understood why I had to leave Earth, and in a way I don't think she'll ever quite forgive me. Some women believe, that love isn't the only thing - but everything. Perhaps they're right... anyway, it's certainly too late to argue now.

'Try and cheer her up when you have a chance. She talks about going back to the mainland. I'm afraid that if she does...

'If you can't get through to her, try to cheer up Chris. I miss him more than I care to say.

'He'll believe Uncle Dimitri - if you say that his father still loves him, and will be coming home just as quickly as he can.'

17

Boarding Party

Even in the best of circumstances, it is not easy to board a derelict and uncooperative spaceship. Indeed, it can be positively dangerous.

Walter Curnow knew that as an abstract principle; but he did not really feel it in his bones until he saw the entire hundred-metre length of Discovery turning end-over-end, while Leonov kept at a safe distance. Years ago, friction had braked the spin of Discovery's carousel, thus transferring its angular momentum to the rest of the structure. Now, like a drum-majorette's baton at the height of its trajectory, the abandoned ship was slowly tumbling along its orbit.

The first problem was to stop that spin, which made Discovery not only uncontrollable but almost unapproachable. As he suited up in the airlock with Max Brailovsky, Curnow had a very rare sensation of incompetence, even inferiority; it was not his line of business. He had already explained gloomily, 'I'm a space engineer, not a space monkey'; but the job had to be done. He alone possessed the skills that could save Discovery from Io's grasp. Max and his colleagues, working with unfamiliar circuit diagrams and equipment, would take far too long. By the time they had restored

power to the ship and mastered its controls, it would have plunged into the sulphurous firepits below.

'You're not scared, are you?' asked Max, when they were about to put on their helmets.

'Not enough to make a mess in my suit. Otherwise, yes.' Max chuckled. 'I'd say that's about right for this job. But don't worry - I'll get you there in one piece, with my - what do you call it?'

'Broomstick. Because witches are supposed to ride them.'

'Oh yes. Have you ever used one?'

'I tried once, but mine got away from me. Everyone else thought it was very funny.'

There are some professions which have evolved unique and characteristic tools - the longshoreman's hook, the potter's wheel, the bricklayer's trowel, the geologist's hammer. The men who had to spend much of their time on zero-gravity construction projects had developed the broomstick.

It was very simple - a hollow tube just a metre long, with a footpad at one end and a retaining loop at the other. At the touch of a button, it could telescope out to five or six times its normal length, and the internal shock-absorbing system allowed a skilled operator to perform the most amazing manoeuvres. The footpad could also become a claw or hook if necessary; there were many other refinements, but that was the basic design. It looked deceptively easy to use; it wasn't.

The airlock pumps finished recycling; the EXIT sign came on; the outer doors opened, and they drifted slowly into the void.

Discovery was windmilling about two hundred metres away, following them in orbit around Io, which filled half the sky. Jupiter was invisible, on the other side of the satellite. This was a matter of deliberate choice; they were using Io as a shield to protect them from the energies raging back and forth in the flux-tube that linked the two worlds. Even so, the radiation level was dangerously high; they had less than fifteen minutes before they must get back to shelter.

Almost immediately, Curnow had a problem with his suit. 'It fitted me when I left Earth,' he complained. 'But now I'm rattling around inside like a pea in a pod.'

'That's perfectly normal, Walter,' said Surgeon-Commander Rudenko, breaking into the radio circuit. 'You lost ten kilos in hibernation, which you could very well afford to miss. And you've already put three of them back.'

Before Curnow had time to think of a suitable retort, he found himself gently but firmly jerked away from Leonov.

'Just relax, Walter,' said Brailovsky. 'Don't use your thrusters, even if you start tumbling. Let me do all the work.'

Curnow could see the faint puffs from the younger man's backpack, as its tiny jets drove them toward Discovery. With each little cloud of vapour there came a gentle tug on the towline, and he would start moving toward Brailovsky; but he never caught up with him before the next puff came. He felt rather like a yo-yo - now making one of its periodic comebacks on Earth - bouncing up and down on its string.

There was only one safe way to approach the derelict, and that was along the axis around which it was slowly revolving. Discovery's centre of rotation was approximately amidships, near the main antenna complex, and Brailovsky was heading directly toward this area, with his anxious

partner in tow. How will he stop both of us in time? Curnow asked himself.

Discovery was now a huge, slender dumbbell slowly flailing the entire sky ahead of them. Though it took several minutes to complete one revolution, the far ends were moving at an impressive speed. Curnow tried to ignore them, and concentrated on the approaching - and immobile - centre.

'I'm aiming for that,' said Brailovsky. 'Don't try to help, and don't be surprised at anything that happens.'

Now, what does he mean by that? Curnow asked himself, while preparing to be as unsurprised as possible.

Everything happened in about five seconds. Brailovsky triggered his broomstick, so that it telescoped out to its full length of four metres and made contact with the approaching ship. The broomstick started to collapse, its internal spring absorbing Brailovsky's considerable momentum; but it did not, as Curnow had fully expected, bring him to rest beside the antenna mount. It immediately expanded again, reversing the Russian's velocity so that he was, in effect, reflected away from Discovery just as rapidly as he had approached. He flashed past Curnow, heading out into space again, only a few centimetres away. The startled American just had time to glimpse a large grin before Brailovsky shot past him.

A second later, there was a jerk on the line connecting them, and a quick surge of deceleration as they shared momentum. Their opposing velocities had been neatly cancelled; they were virtually at rest with respect to Discovery. Curnow had merely to reach out to the nearest handhold, and drag them both in.

'Have you ever tried Russian roulette?' he asked, when he had got his breath back.

'No - what is it?'

'I must teach you sometime. It's almost as good as this for curing boredom.'

'I hope you're not suggesting, Walter, that Max would do anything dangerous?'

Dr Rudenko sounded as if she was genuinely shocked, and Curnow decided it was best not to answer; sometimes the Russians did not understand his peculiar sense of humour. 'You could have fooled me,' he muttered under his breath, not loud enough for her to hear.

Now that they were firmly attached to the hub of the windmilling ship, he was no longer conscious of its rotation - especially when he fixed his gaze upon the metal plates immediately before his eyes. The ladder stretching away into the distance, running along the slender cylinder that was Discovery's main structure, was his next objective. The spherical command module at its far end seemed several light-years away, though he knew perfectly well that the distance was only fifty metres.

'I'll go first,' said Brailovsky, reeling in the slack on the line linking them together. 'Remember - it's downhill all the way from here. But that's no problem - you can hold on with one hand. Even at the bottom, gravity's only about a tenth gee. And that's - what do you say? - chickenshit.'

'I think you mean chickenfeed. And if it's all the same to you, I'm going feet first. I never liked crawling down ladders the wrong way up - even in fractional gravity.'

It was essential, Curnow was very well aware, to keep up this gently bantering tone; otherwise he would be simply overwhelmed by the mystery and danger of the situation. There he was, almost a billion kilometres from home, about to enter the most famous derelict in the entire history of space exploration; a media reporter had once called

Discovery the Marie Celeste of space, and that was not a bad analogy. But there was also much that made his situation unique; even if he tried to ignore the nightmare moonscape filling half the sky, there was a constant reminder of its presence at hand. Every time he touched the rungs of the ladder, his glove dislodged a thin mist of sulphur dust.

Brailovsky, of course, was quite correct; the rotational gravity caused by the ship's end-over-end tumbling was easily countered. As he grew used to it, Curnow even welcomed the sense of direction it gave him.

And then, quite suddenly, they had reached the big, discoloured sphere of Discovery's control and life-support module. Only a few metres away was an emergency hatch - the very one, Curnow realized, that Bowman had entered for his final confrontation with Hal.

'Hope we can get in,' muttered Brailovsky. 'Pity to come all this way and find the door locked.'

He scraped away the sulphur obscuring the AIRLOCK STATUS display panel.

'Dead, of course. Shall I try the controls?'

'Won't do any harm - but nothing will happen.'

'You're right. Well, here goes with manual...

It was fascinating to watch the narrow hairline open in the curved wall, and to note the little puff of vapour dispersing into space, carrying with it a scrap of paper. Was that some vital message? They would never know; it spun away, tumbling end over end without losing any of its initial spin as it disappeared against the stars.

Brailovsky kept turning the manual control for what seemed a very long time, before the dark, uninviting cave of the airlock was completely open.

Curnow had hoped that the emergency lights, at least, might still be operating. No such luck.

'You're boss now, Walter. Welcome to US territory.'

It certainly did not look very welcoming as he clambered inside, flashing the beam of his helmet light around the interior. As far as Curnow could tell, everything was in good order. What else had he expected? he asked himself, half angrily.

Closing the door manually took even longer than opening it, but there was no alternative until the ship was powered up again. Just before the hatch was sealed, Curnow risked a glance at the insane panorama outside.

A flickering blue lake had opened up near the equator; he was sure it had not been there a few hours earlier. Brilliant yellow flares, the characteristic colour of glowing sodium, were dancing along its edges; and the whole of the nightland was veiled in the ghostly plasma discharge of one of Io's almost continuous auroras.

It was the stuff of future nightmares - and as if that was not sufficient, there was one further touch worthy of a mad surrealist artist. Stabbing up into the black sky, apparently emerging directly from the firepits of the burning moon, was an immense, curving horn, such as a doomed bullfighter might have glimpsed in the final moment of truth.

The crescent of Jupiter was rising to greet Discovery and Leonov as they swept toward it along their common orbit.

Salvage

The moment that the outer hatch had closed behind them, there had been a subtle reversal of roles. Curnow was at home now, while Brailovsky was out of his element, feeling ill at ease in the labyrinth of pitch-black corridors and tunnels that was Discovery's interior. In theory, Max knew his way round the ship, but that knowledge was based only on a study of its design drawings. Curnow, on the other hand, had spent months working in Discovery's still uncompleted identical twin; he could, quite literally, find his way around blindfolded.

Progress was made difficult because that part of the ship was designed for zero gee; now the uncontrolled spin provided an artificial gravity, which, slight though it was, always seemed to be in the most inconvenient direction.

'First thing we've got to do,' muttered Curnow, after sliding several metres down a corridor before he could grab a handhold, 'is to stop this damned spin. And we can't do that until we have power. I only hope that Dave Bowman safeguarded all systems before he abandoned ship.'

'Are you sure he did abandon the ship? He may have intended to come back.'

'You may be right; I don't suppose we'll ever know. If he even knew himself.'

They had now entered the Pod Bay - Discovery's 'space garage', which normally contained three of the spherical one-man modules used for activities outside the ship. Only Pod Number 3 remained; Number 1 had

been lost in the mysterious accident that had killed Frank Poole - and Number 2 was with Dave Bowman, wherever he might be.

The Pod Bay also contained two spacesuits, looking uncomfortably like decapitated corpses as they hung helmet-less in their racks. It needed very little effort of the imagination - and Brailovsky's was now working overtime - to fill them with a whole menagerie of sinister occupants.

It was unfortunate, but not altogether surprising, that Curnow's sometimes irresponsible sense of humour got the better of him at this very moment.

'Max,' he said, in a tone of deadly seriousness, 'whatever happens - please don't go chasing off after the ship's cat.'

For a few milliseconds, Brailovsky was thrown off guard; he almost answered: 'I do wish you hadn't said that, Walter', but checked himself in time. That would have been too damning an admission of weakness; instead he replied, 'I'd like to meet the idiot who put that movie in our library.'

'Katerina probably did it, to test everyone's psychological balance. Anyway, you laughed your head off when we screened it last week.'

Brailovsky was silent; Curnow's remark was perfectly true. But that had been back in the familiar warmth and light of Leonov, among his friends - not in a pitch-black, freezing derelict, haunted by ghosts. No matter how rational one was, it was all too easy to imagine some implacable alien beast prowling these corridors, seeking whom it might devour.

It's all your fault, Grandma (may the Siberian tundra lie lightly on your beloved bones) - I wish you hadn't filled my mind with so many of those gruesome legends. If I close my eyes, I can still see the hut of the Baba Yaga, standing in that forest clearing on its scrawny chicken legs...

Enough of this nonsense. I'm a brilliant young engineer faced with the biggest technical challenge of his life, and I mustn't let my American friend know that I'm sometimes a frightened little boy.

The noises did not help. There were too many of them, though they were so faint that only an experienced astronaut would have detected them against the sounds of his own suit. But to Max Brailovsky, accustomed to working in an environment of utter silence, they were distinctly unnerving, even though he knew that the occasional cracklings and creakings were almost certainly caused by thermal expansion as the ship turned like a roast on a spit. Feeble though the sun was out here, there was still an appreciable temperature change between light and shade.

Even his familiar spacesuit felt wrong, now that there was pressure outside as well as in. All the forces acting on its joints were subtly altered, and he could no longer judge his movements accurately. I'm a beginner, starting my training all over again, he told himself angrily. Time to break the mood by some decisive action.

'Walter - I'd like to test the atmosphere.'

'Pressure's okay; temperature - phew - it's one hundred five below zero.'

'A nice bracing Russian winter. Anyway, the air in my suit will keep out the worst of the cold.'

'Well, go ahead. But let me shine my light on your face, so I can see if you start to turn blue. And keep talking.'

Brailovsky unsealed his visor and swung the faceplate upward. He flinched momentarily as icy fingers seemed to caress his cheeks, then took a cautious sniff, followed by a deeper breath.

'Chilly - but my lungs aren't freezing. There's a funny smell, though. Stale, rotten - as if something's - oh no!'

Looking suddenly pale, Brailovsky quickly snapped the faceplate shut.

'What's the trouble, Max?' Curnow asked with sudden and now perfectly genuine anxiety. Brailovsky did not reply; he looked as if he was still trying to regain control of himself. Indeed, he seemed in real danger of that always horrible and sometimes fatal disaster - vomiting in a spacesuit.

There was a long silence; then Curnow said reassuringly:

'I get it. But I'm sure you're wrong. We know that Poole was lost in space. Bowman reported that he... ejected the others after they died in hibernation - and we can be sure that he did. There can't be anyone here. Besides, it's so cold.' He almost added 'like a morgue' but checked himself in time.

'But' suppose,' whispered Brailovsky, 'just suppose Bowman managed to get back to the ship - and died here.'

There was an even longer silence before Curnow deliberately and slowly opened his own faceplate. He winced as the freezing air bit into his lungs, then wrinkled his nose in disgust.

'I see what you mean. But you're letting your imagination run away with you. I'll bet you ten to one that smell comes from the galley. Probably some meat went bad, before the ship froze up. And Bowman must have been too busy to be a good housekeeper. I've known bachelor apartments that smelled as bad as this.'

'Maybe you're right. I hope you are.'

'Of course I am. And even if I'm not - dammit, what difference does it make? We've got a job to do, Max. If Dave Bowman's still here, that's not our department - is it, Katerina?'

There was no reply from the Surgeon-Commander; they had gone too far inside the ship for radio to penetrate. They were indeed on their own, but Max's spirits were rapidly reviving. It was a privilege, he decided, to work with Walter. The American engineer sometimes appeared soft and easygoing. But he was totally competent - and, when necessary, as hard as nails.

Together, they would bring Discovery back to life; and, perhaps, back to Earth.

19

Operation WINDMILL

When Discovery suddenly lit up like the proverbial Christmas tree, navigation and interior lights blazing from end to end, the cheer aboard Leonov might almost have been heard across the vacuum between the two ships. It turned into an ironic groan when the lights promptly went out again.

Nothing else happened for half an hour; then the observation windows of Discovery's flight deck began to glow with the soft crimson of the emergency lights. A few minutes later, Curnow and Brailovsky could be seen moving around inside, their figures blurred by the film of sulphur dust.

'Hello, Max - Walter - can you hear us?' called Tanya Orlova. Both the figures waved instantly, but made no other reply. Obviously, they were too busy to engage in casual conversation; the watchers on Leonov had to wait patiently while various lights flashed on and off, one of the three Pod Bay

doors slowly opened and quickly closed, and the main antenna slewed around a modest ten degrees.

'Hello, Leonov,' said Curnow at last. 'Sorry to keep you waiting, but we've been rather busy.'

'Here's a quick assessment, judging from what we've seen so far. The ship's in much better shape than I feared. Hull's intact, leakage negligible - air pressure eighty-five per cent nominal. Quite breathable, but we'll have to do a major recycling job because it stinks to high heaven.'

'The best news is that the power systems are okay. Main reactor stable, batteries in good shape. Almost all the circuit-breakers were open - they'd jumped or been thrown by Bowman before he left - so all vital equipment's been safeguarded. But it will be a very big job checking everything before we have full power again.'

'How long will that take - at least for the essential systems: life-support, propulsion?'

'Hard to say, skipper. How long before we crash?'

'Minimum present prediction is ten days. But you know how that's changed up - and down.'

'Well, if we don't run into any major snags, we can haul Discovery up to a stable orbit away from this hellhole - oh, I'd say inside a week.'

'Anything you need?'

'No - Max and I are doing fine. We're going into the carousel now, to check the bearings. I want to get it running as soon as possible.'

'Pardon me, Walter - but is that important? Gravity's convenient, but we've managed without any for quite a while.'

'I'm not after gravity, though it will be useful to have some aboard. If we can get the carousel running again, it will mop up the ship's spin - stop it tumbling. Then we'll be able to couple our airlocks together, and cut out EVAs. That will make work a hundred times easier.'

'Nice idea, Walter - but you're not going to mate my ship to that... windmill. Suppose the bearings seize up and the carousel jams? That would tear us to pieces.'

'Agreed. We'll cross that bridge when we come to it. I'll report again as soon as I can.'

No one had much rest for the next two days. By the end of that time, Curnow and Brailovsky had practically fallen asleep in their suits, but had completed their survey of Discovery and found no unpleasant surprises. Both the Space Agency and the State Department were relieved by the preliminary report; it allowed them to claim, with some justification, that Discovery was not a derelict but a 'temporarily decommissioned United States Spacecraft'. Now the task of reconditioning had to begin.

Once power had been restored, the next problem was the air; even the most thorough housecleaning operations had failed to remove the stink. Curnow had been right in identifying its source as food spoiled when refrigeration had failed; he also claimed, with mock seriousness, that it was quite romantic. 'I've only got to close my eyes,' he asserted, 'and I feel I'm back on an old-time whaling ship. Can you imagine what the Pequod must have smelled like?'

It was unanimously agreed that, after a visit to Discovery, very little effort of the imagination was required. The problem was finally solved - or at least reduced to manageable proportions - by dumping the ship's atmosphere. Fortunately, there was still enough air in the reserve tanks to replace it.

One piece of very welcome news was that ninety per cent of the propellant needed for the return journey was still available; choosing ammonia instead of hydrogen as working fluid for the plasma drive had paid off handsomely. The more efficient hydrogen would have boiled off into space years ago, despite the insulation of the tanks and the frigid temperature outside. But almost all the ammonia had remained safely liquified, and there was enough to get the ship back to a safe orbit around the Earth. Or at least around the Moon.

Checking Discovery's propellerlike spin was perhaps the most critical step in getting the ship under control. Sasha Kovalev compared Curnow and Brailovsky to Don Quixote and Sancho Panza, and expressed the hope that their windmill-tilting expedition would end more successfully.

Very cautiously, with many pauses for checking, power was fed to the carousel motors and the great drum was brought up to speed, reabsorbing the spin it had long ago imparted to the ship. Discovery executed a complex series of precessions, until eventually its end-over-end tumble had almost vanished. The last traces of unwanted rotation were neutralized by the attitude-control jets, until the two ships were floating motionless side by side, the squat, stocky Leonov dwarfed by the long, slender Discovery.

Transfer from one to the other was now safe and easy, but Captain Orlova still refused to permit a physical linkup. Everyone agreed with this decision, for Io was coming steadily closer; they might yet have to abandon the vessel they had worked so hard to save.

The fact that they now knew the reason for Discovery's mysterious orbital decay did not help in the least. Every time the ship passed between Jupiter and Io, it sliced through the invisible flux-tube linking the two bodies - the electric river flowing from world to world. The resulting eddy currents induced in the ship were continually slowing it down, braking it once every revolution.

There was no way to predict the final moment of impact, for the current in the flux-tube varied wildly according to Jupiter's own inscrutable laws. Sometimes there were dramatic surges of activity accompanied by spectacular electric and auroral storms around Io. Then the ships would lose altitude by many kilometres, at the same time becoming uncomfortably hot before their thermal control systems could readjust.

This unexpected effect had scared and surprised everyone before the obvious explanation was realized. Any form of braking produces heat, somewhere; the heavy currents induced in the hulls of Leonov and Discovery turned them briefly into low-powered electric furnaces. It was not surprising that some of Discovery's food supply had been ruined during the years the ship had been alternately cooked and cooled.

The festering landscape of Io, looking more than ever like an illustration from a medical textbook, was only five hundred kilometres away when Curnow risked activating the main drive, while Leonov stood off at a very respectful distance. There were no visible effects - none of the smoke and fire of the old-time chemical rockets - but the two ships drew slowly apart as Discovery gained speed. After a few hours of very gentle manoeuvring, both ships had raised themselves a thousand kilometres; now there was time to relax briefly, and to make plans for the next stage in the mission.

'You've done a wonderful job, Walter,' said Surgeon-Commander Rudenko, putting her ample arm around the exhausted Curnow's shoulders. 'We're all proud of you.'

Very casually, she broke a small capsule under his nose. It was twenty-four hours before he woke up, annoyed and hungry.

Guillotine

'What is it?' asked Curnow with mild distaste, hefting the little mechanism in his hand. 'A guillotine for mice?'

'Not a bad description - but I'm after bigger game.' Floyd pointed to a flashing arrow on the display screen, which was now showing a complicated circuit diagram.

'You see this line?'

'Yes - the main power supply. So?'

'This is the point where it enters Hal's central processing unit. I'd like you to install this gadget here. Inside the cable trunking, where it can't be found without a deliberate search.'

'I see. A remote control, so you can pull the plug on Hal whenever you want to. Very neat - and a non-conducting blade, too, so there won't be any embarrassing shorts when it's triggered. Who makes toys like this? The CIA?'

'Never mind. The control's in my room - that little red calculator I always keep on my desk. Put in nine nines, take the square root, and press TNT. That's all. I'm not sure of its range - we'll have to test that - but as long as Leonov and Discovery are within a couple of kilometres of each other, there'll be no danger of Hal running amok again.'

'Who are you going to tell about this... thing?'

'Well, the only person I'm really hiding it from is Chandra.'

'I guessed as much.'

'But the fewer who know, the less likely it is to be talked about. I'll tell Tanya that it exists, and if there's an emergency you can show her how to operate it.'

'What kind of emergency?'

'That's not a very bright question, Walter. If I knew, I wouldn't need the damn thing.'

'Guess you're right. When do you want me to install your patented Hal-zapper?'

'As soon as you can. Preferably tonight. When Chandra's sleeping.'

'Are you kidding? I don't think he ever sleeps. He's like a mother nursing a sick baby.'

'Well, he's got to come back to Leonov to eat, occasionally.'

'I've news for you. The last time he went across, he tied a little sack of rice to his suit. That will keep him going for weeks.'

'Then we'll have to use one of Katerina's famous knockout drops. They did a pretty good job on you, didn't they?'

Curnow was joking about Chandra - at least, Floyd assumed that he was, though one could never be quite sure: he was fond of making outrageous statements with a perfectly straight face. It had been some time before the Russians had fully realized that; soon, in self-defence, they

were prone to pre-emptive laughs even when Curnow was being perfectly serious.

Curnow's own laugh, mercifully, had much abated since Floyd had first heard it in the upward-bound shuttle; on that occasion, it had obviously been primed by alcohol. He had fully expected to cringe from it again at the end-of-orbit party, when Leonov had finally made rendezvous with Discovery. But even on that occasion, though Curnow had drunk a good deal, he had remained as much under control as Captain Orlova herself.

The one thing he did take seriously was his work. On the way up from Earth, he had been a passenger. Now he was crew.

21

Resurrection

We are, Floyd told himself, about to awaken a sleeping giant. How will Hal react to our presence, after all these years? What will he remember of the past - and will he be friendly, or hostile?

As he floated just behind Dr Chandra in the zero-gravity environment of Discovery's flight deck, Floyd's mind was seldom far from the cut-off switch, installed and tested only a few hours earlier. The radio control was mere centimetres from his hand, and he felt somewhat foolish to have brought it with him. At this stage, Hal was still disconnected from all the ship's operational circuits. Even if he was reactivated, he would be a brain without limbs though not without sense organs. He would be able to communicate, but not to act. As Curnow had put it, 'The worst he can do is swear at us.'

'I'm ready for the first test, Captain,' said Chandra. 'All the missing modules have been replaced, and I've run diagnostic programs on all circuits. Everything appears normal, at least on this level.'

Captain Orlova glanced at Floyd, who gave a nod. At Chandra's insistence, only the three of them were present for this critical first run, and it was quite obvious that even this small audience was unwelcome.

'Very well, Dr Chandra.' Ever conscious of protocol, the captain added quickly: 'Dr Floyd has given his approval, and I have no objections myself.'

'I should explain,' said Chandra, in a tone that clearly conveyed disapproval, 'that his voice-recognition and speech-synthesis centres have been damaged. We'll have to teach him to speak all over again. Luckily, he learns several million times faster than a human being.'

The scientist's fingers danced over the keyboard as he typed out a dozen words, apparently at random, carefully pronouncing each one as it appeared on the screen. Like a distorted echo, the words came back from the speaker grille - lifeless, indeed mechanical, with no sense of any intelligence behind them. This isn't the old Hal, thought Floyd. It's no better than the primitive speaking toys that were such a novelty when I was a kid.

Chandra pressed the REPEAT button, and the series of words sounded once again. Already, there was a noticeable improvement, though no one could have mistaken the speaker for a human being.

'The words I gave him contain the basic English phonemes; about ten iterations, and he'll be acceptable. But I don't have the equipment to do a really good job of therapy.'

'Therapy?' asked Floyd. 'You mean that 'he's - well, brain-damaged?'

'No,' snapped Chandra. 'The logic circuits are in perfect condition. Only the voice output may be defective, though it will improve steadily. So check everything against the visual display, to avoid misinterpretations. And when you do speak, enunciate carefully.'

Floyd gave Captain Orlova a wry smile, and asked the obvious question.

'What about all the Russian accents around here?'

'I'm sure that won't be a problem with Captain Orlova and Dr Kovalev. But with the others - well, we'll have to run individual tests. Anyone who can't pass will have to use the keyboard.'

'That's still looking a long way ahead. For the present, you're the only person who should attempt communication. Agreed, Captain?'

'Absolutely.'

Only the briefest of nods revealed that Dr Chandra had heard them. His fingers continued to fly over the keyboard, and columns of words and symbols flashed across the display screen at such a rate that no human being could possibly assimilate them. Presumably Chandra had an eidetic memory, for he appeared to recognize whole pages of information at a glance.

Floyd and Orlova were just about to leave the scientist to his arcane devotions when he suddenly acknowledged their presence again, holding up his hand in warning or anticipation. With an almost hesitant movement, in marked contrast with his previous swift actions, he slid back a locking bar and pressed a single, isolated key.

Instantly, with no perceptible pause, a voice came from the console, no longer in a mechanical parody of human speech. There was intelligence -

consciousness - self-awareness here, though as yet only on a rudimentary level.

'Good morning, Dr Chandra, This is Hal. I am ready for my first lesson.'

There was a moment of shocked silence; then, acting on the same impulse, the two observers left the deck.

Heywood Floyd would never have believed it. Dr Chandra was crying.

IV

LaGRANGE

Big Brother

'... What delightful news about the baby dolphin! I can just imagine how excited Chris was when the proud parents brought it into the house. You should have heard the ohs and ahs of my shipmates when they saw the videos of them swimming together, and Chris riding on its back. They suggest we call it Sputnik, which means companion as well as satellite.

'Sorry it's been quite a while since my last message, but the newscasts will have given you an idea of the huge job we've had to do. Even Captain Tanya's given up all pretence of a regular schedule; each problem has to be fixed as it comes along, by whoever is on the spot. We sleep when we can't stay awake any longer.

'I think we can all be proud of what we've done. Both ships are operational and we've nearly finished our first round of tests on Hal. In a couple of days we'll know if we can trust him to fly Discovery when we leave here to make our final rendezvous with Big Brother.

'I don't know who first gave it that name - the Russians, understandably, aren't keen on it. And they've waxed quite sarcastic about our official designation TMA-2, pointing out to me - several times - that it's the best part of a billion kilometres from Tycho. Also that Bowman reported no magnetic anomaly, and that the only resemblance to TMA-1 is the shape. When I asked them what name they preferred, they came up with Zagadka, which means enigma. It's certainly an excellent name; but everyone smiles when I try to pronounce it, so I'll stick to Big Brother.

'Whatever you call the thing, it's only ten thousand kilometres away now, and the trip won't take more than a few hours. But that last lap has us all nervous, I don't mind telling you.

'We'd hoped that we might find some new information aboard Discovery. That's been our only disappointment, though we should have expected it. Hal, of course, was disconnected long before the encounter, and so has no memories of what happened; Bowman has taken all his secrets with him. There's nothing in the ship's log and automatic recording systems that we didn't already know.

'The only new item we discovered was purely personal - a message that Bowman had left for his mother. I wonder why he never sent it; obviously, he did expect - or hope - to return to the ship after that last EVA. Of course, we've had it forwarded to Mrs Bowman - she's in a nursing home, somewhere in Florida, and her mental condition is poor, so it may not mean anything to her.

'Well, that's all the news this time. I can't tell you how much I miss you... and the blue skies and green seas of Earth. All the colours here are reds and oranges and yellows - often as beautiful as the most fantastic sunset, but after a while one grows sick for the cool, pure rays at the other end of the spectrum.

'My love to you both - I'll call again just as soon as I can.'

Rendezvous

Nikolai Temovsky, Leonov's control and cybernetics expert, was the only man aboard who could talk to Dr Chandra on something like his own terms. Although Hal's principal creator and mentor was reluctant to admit anyone into his full confidence, sheer physical exhaustion had forced him to accept help. Russian and Indo-American had formed a temporary alliance, which functioned surprisingly well. Most of the credit for this went to the good-natured Nikolai, who was somehow able to sense when Chandra really needed him, and when he preferred to be alone. The fact that Nikolai's English was much the worst on the ship was totally unimportant, since most of the time both men spoke a computerese wholly unintelligible to anyone else.

After a week's slow and careful reintegration, all of Hal's routine, supervisory functions were operating reliably. He was like a man who could walk, carry out simple orders, do unskilled jobs, and engage in low-level conversation. In human terms, he had an Intelligence Quotient of perhaps 50; only the faintest outlines of his original personality had yet emerged.

He was still sleepwalking; nevertheless, in Chandra's expert opinion, he was now quite capable of flying Discovery from its close orbit around Io up to the rendezvous with Big Brother.

The prospect of getting an extra seven thousand kilometres away from the burning hell beneath them was welcomed by everyone. Trivial though that distance was in astronomical terms, it meant that the sky would no longer be dominated by a landscape that might have been imagined by Dante or Hieronymus Bosch. And although not even the most violent

eruptions had blasted any material up to the ships, there was always the fear that Io might attempt to set a new record. As it was, visibility from Leonov's observation deck was steadily degraded by a thin film of sulphur, and sooner or later someone would have to go out and clean it off.

Only Curnow and Chandra were aboard Discovery when Hal was given the first control of the ship. It was a very limited form of control; he was merely repeating the program that had been fed into his memory, and monitoring its execution. And the human crew was monitoring him: if any malfunction occurred, they would take over immediately.

The first burn lasted for ten minutes; then Hal reported that Discovery had entered the transfer orbit. As soon as Leonov's radar and optical tracking confirmed that, the other ship injected itself into the same trajectory. Two minor in-course corrections were made; then, three hours and fifteen minutes later, both arrived uneventfully at the first Lagrange point, L. 1 - 10,500 kilometres up, on the invisible line connecting the centres of Io and Jupiter.

Hal had behaved impeccably, and Chandra showed unmistakable traces of such purely human emotions as satisfaction and even joy. But by that time, everyone's thoughts were elsewhere; Big Brother, alias Zagadka, was only a hundred kilometres away.

Even from that distance, it already appeared larger than the Moon as seen from Earth, and shockingly unnatural in its straight-edged, geometrical perfection. Against the background of space it would have been completely invisible, but the scudding Jovian clouds 350,000 kilometres below showed it up in dramatic relief. They also produced an illusion that, once experienced, the mind found almost impossible to refute. Because there was no way in which its real location could be judged by the eye, Big Brother often looked like a yawning trapdoor set in the face of Jupiter.

There was no reason to suppose that a hundred kilometres would be 'safer than ten, or more dangerous than a thousand; it merely seemed psychologically right for a first reconnaissance. From that distance, the ship's telescopes could have revealed details only centimetres across -but there were none to be seen. Big Brother appeared completely featureless; which, for an object that had, presumably, survived millions of years of bombardment by space debris, was incredible.

When Floyd stared through the binocular eyepiece, it seemed to him that he could reach out and touch those smooth, ebon surfaces - just as he had done on the Moon, years ago. That first time, it had been with the gloved hand of his spacesuit. Not until the Tycho monolith had been enclosed in a pressurized dome had he been able to use his naked hand.

That had made no difference; he did not feel that he had ever really touched TMA-1. The tips of his fingers had seemed to skitter over an invisible barrier, and the harder he pushed, the greater the repulsion grew. He wondered if Big Brother would produce the same effect.

Yet before they came that close, they had to make every test they could devise and report their observations to Earth. They were in much the same position as explosives experts trying to defuse a new type of bomb, which might be detonated by the slightest false move. For all that they could tell, even the most delicate of radar probes might trigger some unimaginable catastrophe.

For the first twenty-four hours, they did nothing except observe with passive instruments - telescopes, cameras, sensors on every wavelength. Vasili Orlov also took the opportunity of measuring the slab's dimensions with the greatest possible precision, and confirmed the famous 1:4:9 ratio to six decimal places. Big Brother was exactly the same shape as TMA-1 - but as it was more than two kilometres long, it was 718 times larger than its small sibling.

And there was a second mathematical mystery. Men had been arguing for years over that 1:4:9 ratio - the squares of the first three integers. That could not possibly be a coincidence; now here was another number to conjure with.

Back on Earth, statisticians and mathematical physicists were soon playing happily with their computers, trying to relate the ratio to the fundamental constants of nature - the velocity of light, the proton/electron mass ratio, the fine-structure constant. They were quickly joined by a gaggle of numerologists, astrologers, and mystics, who threw in the height of the Great Pyramid, the diameter of Stonehenge, the azimuth bearings of the Nazca lines, the latitude of Easter Island, and a host of other factors from which they were able to draw the most amazing conclusions about the future. They were not in the least deterred when a celebrated Washington humorist claimed that his calculations proved that the world ended on 31 December 1999 - but that everyone had had too much of a hangover to notice.

Nor did Big Brother appear to notice the two ships that had arrived in its vicinity - even when they cautiously probed it with radar beams and bombarded it with strings of radio pulses which, it was hoped, would encourage any intelligent listener to answer in the same fashion.

After two frustrating days, with the approval of Mission Control, the ships halved their distance. From fifty kilometres, the largest face of the slab appeared about four times the width of the Moon in Earth's sky - impressive, but not so large as to be psychologically overwhelming. It could not yet compete with Jupiter, ten times larger still; and already the mood of the expedition was changing from awed alertness to a certain impatience.

Walter Curnow spoke for almost everyone: 'Big Brother may be willing to wait a few million years - we'd like to get away a little sooner.'

Reconnaissance

Discovery had left Earth with three of the little space pods that allowed an astronaut to perform extravehicular activities in shirt-sleeve comfort. One had been lost in the accident - if it was an accident - that had killed Frank Poole. Another had carried Dave Bowman to his final appointment with Big Brother, and shared whatever fate befell him. A third was still in the ship's garage, the Pod Bay.

It lacked one important component - the hatch, blown off by Commander Bowman when he had made his hazardous vacuum-crossing and entered the ship through the emergency airlock, after Hal had refused to open the Pod Bay door. The resulting blast of air had rocketed the pod several hundred kilometres away before Bowman, busy with more important matters, had brought it back under radio control. It was not surprising that he had never bothered to replace the missing hatch.

Now Pod Number 3 (on which Max, refusing all explanations, had stencilled the name Nina) was being prepared for another EVA. It still lacked a hatch, but that was unimportant. No one would be riding inside.

Bowman's devotion to duty was a piece of unexpected luck, and it would have been folly not to take advantage of it. By using Nina as a robot probe, Big Brother could be examined at close quarters without risking human lives. That at least was the theory; no one could rule out the possibility of a backlash that might engulf the ship. After all, fifty kilometres was not even a hair's breadth, as cosmic distances went.

After years of neglect, Nina looked distinctly shabby. The dust that was always floating around in zero gee had settled over the outer surface, so

that the once immaculately white hull had become a dingy grey. As it slowly accelerated away from the ship, its external manipulators folded neatly back and its oval viewport staring spaceward like a huge, dead eye, it did not seem a very impressive ambassador of Mankind. But that was a distinct advantage; so humble an emissary might be tolerated, and its small size and low velocity should emphasize its peaceful intentions. There had been a suggestion that it should approach Big Brother with open hands; the idea was quickly turned down when almost everyone agreed that if they saw Nina heading toward them, mechanical claws outstretched, they would run for their lives.

After a leisurely two-hour trip, Nina came to rest a hundred metres from one corner of the huge rectangular slab. From so close at hand, there was no sense of its true shape; the TV cameras might have been looking down on the tip of a black tetrahedron of indefinite size. The onboard instruments showed no sign of radioactivity or magnetic fields; nothing whatsoever was coming from Big Brother except the tiny fraction of sunlight it condescended to reflect.

After five minutes' pause - the equivalent, it was intended, of 'Hello, here I am!' - Nina started a diagonal crossing of the smaller face, then the next larger, and finally the largest, keeping at a distance of about fifty metres, but occasionally coming in to five. Whatever the separation, Big Brother looked exactly the same - smooth and featureless. Long before the mission was completed, it had become boring, and the spectators on both ships had gone back to their various jobs, only glancing at the monitors from time to time.

'That's it,' said Walter Curnow at last, when Nina had arrived back where she had started. 'We could spend the rest of our lives doing this, without learning anything more. What do I do with Nina - bring her home?'

'No,' said Vasili, breaking into the circuit from aboard Leonov. 'I've a suggestion. Take her to the exact centre of the big face. Bring her to rest -

oh, a hundred metres away. And leave her parked there, with the radar switched to maximum precision.'

'No problem - except that there's bound to be some residual drift. But what's the point?'

'I've just remembered an exercise from one of my college astronomy courses - the gravitational attraction of an infinite flat plate. I never thought I'd have a chance of using it in real life. After I've studied Nina's movements for a few hours, at least I'll be able to calculate Zagadka's mass, That is, if it has any. I'm beginning to think there's nothing really there.'

'There's an easy way to settle that, and we'll have to do it eventually. Nina must go in and touch the thing.'

'She already has.'

'What do you mean?' asked Curnow, rather indignantly. 'I never got nearer than five metres.'

'I'm not criticizing your driving skills - though it was a pretty close thing at that first corner, wasn't it? But you've been tapping gently on Zagadka every time you use Nina's thrusters near its surface.'

'A flea jumping on an elephant!'

'Perhaps. We simply don't know. But we'd better assume that, one way or another, it's aware of our presence, and will only tolerate us as long as we aren't a nuisance.'

He left the unspoken question hanging in the air. How did one annoy a two-kilometre-long black rectangular slab? And just what form would its disapproval take?

The View from Lagrange

Astronomy was full of such intriguing but meaningless coincidences. The most famous was the fact that, from the Earth, both Sun and Moon have the same apparent diameter. Here at the L.1 libration point, which Big Brother had chosen for its cosmic balancing act on the gravitational tightrope between Jupiter and Io, a similar phenomenon occurred. Planet and satellite appeared exactly the same size.

And what a size! Not the miserable half-degree of Sun and Moon, but forty times their diameter - sixteen hundred times their area. 'The sight of either was enough to fill the mind with awe and wonder; together, the spectacle was overwhelming.

Every forty-two hours, they would go through their complete cycle of phases; when Io was new, Jupiter was full, and vice versa. But even when the Sun was hiding behind Jupiter and the planet presented only its night side, it was unmistakably there - a huge black disk eclipsing the stars. Sometimes that blackness would be momentarily rent by lightning flashes lasting for many seconds, from electrical storms far larger than the Earth.

On the opposite side of the sky, always keeping the same face toward its giant master, Io would be a sluggishly boiling cauldron of reds and oranges, with occasional yellow clouds erupting from one of its volcanoes, and falling swiftly back to the surface. Like Jupiter, but on a slightly longer time scale, Io was a world without geography. Its face was remodelled in a matter of decades - Jupiter's, in a matter of days.

As Io waned toward its last quarter, so the vast, intricately banded Jovian cloudscape would light up beneath the tiny, distant sun. Sometimes the shadow of Io itself, or one of the outer satellites, would drift across the face of Jupiter; while every revolution would show the planet-sized vortex of the Great Red Spot - a hurricane that had endured for centuries if not for millennia.

Poised between such wonders, the crew of Leonov had material for lifetimes of research - but the natural objects of the Jovian system were at the very bottom of their list of priorities. Big Brother was Number 1; though the ships had now moved in to only five kilometres, Tanya still refused to allow any direct physical contact. 'I'm going to wait,' she said, 'until we're in a position to make a quick getaway. We'll sit and watch - until our launch window opens. Then we'll consider our next move.'

It was true that Nina had finally grounded on Big Brother, after a leisurely fifty-minute fall. This had allowed Vasili to calculate the object's mass as a surprisingly low 950,000 tons, which gave it about the density of air. Presumably it was hollow - which provoked endless speculation about what might be inside.

But there were plenty of practical, everyday problems to take their minds off these greater issues. Housekeeping chores aboard Leonov and Discovery absorbed ninety per cent of their working time, though operations' were much more efficient since the two ships had been coupled by a flexible docking connection. Curnow had finally convinced Tanya that Discovery's carousel would not suddenly seize up and tear the ships to pieces, so it had become possible to move freely from one vessel to the other merely by opening and closing two sets of airtight doors. Spacesuits and time-consuming EVAs were no longer necessary - to the great delight of everyone except Max, who loved going outside and exercising with his broomstick.

The two crew members quite unaffected by this were Chandra and Ternovsky, who now virtually lived aboard Discovery and worked around

the clock, continuing their apparently endless dialogue with Hal. 'When will you be ready?' they were asked at least once a day. They refused to make any promises; Hal remained a low-grade moron.

Then, a week after the rendezvous with Big Brother, Chandra unexpectedly announced: 'We're ready.'

Only the two lady medics were absent from Discovery's flight deck, and that was merely because there was no room for them; they were watching on Leonov's monitors. Floyd stood immediately behind Chandra, his hand never far from what Curnow, with his usual gift for the neat phrase, had called his pocket giant-killer.

'Let me emphasize again,' said Chandra, 'that there must be no talking. Your accents will confuse him; I can speak, but no one else. Is that understood?'

Chandra looked, and sounded, at the edge of exhaustion. Yet his voice held a note of authority that no one had ever heard before. Tanya might be the boss everywhere else, but he was master there.

The audience - some anchored to convenient handholds, some floating freely - nodded assent. Chandra closed an audio switch and said, quietly but clearly: 'Good morning, Hal.'

An instant later, it seemed to Floyd that the years had rolled away. It was no longer a simple electronic toy that answered back. Hal had returned.

'Good morning, Dr Chandra.'

'Do you feel capable of resuming your duties?'

'Of course. I am completely operational and all my circuits are functioning perfectly.'

'Then do you mind if I ask you a few questions?'

'Not at all.'

'Do you recall a failure of the AE 35 antenna control unit?'

'Certainly not.'

Despite Chandra's injunction, there was a little gasp from the listeners. This is like tiptoeing through a minefield, thought Floyd, as he patted the reassuring shape of the radio cut-off. If that line of questioning triggered another psychosis, he could kill Hal in a second. (He knew, having rehearsed the procedure a dozen times.) But a second was aeons to a computer; that was a chance they would have to take.

'You do not remember either Dave Bowman or Frank Poole going out to replace the AE 35 unit?'

'No. That could not have happened, or I would have remembered it. Where are Frank and Dave? Who are these people? I can only identify you - though I compute a sixty-five per cent probability that the man behind you is Dr Heywood Floyd.'

Remembering Chandra's strict injunction, Floyd refrained from congratulating Hal. After a decade, sixty-five per cent was a pretty good score. Many humans would not have done so well.

'Don't worry, Hal - I will explain everything later.'

'Has the mission been completed? You know I have the greatest enthusiasm for it.'

'The mission has been completed; you have carried out your program. Now - if you will excuse us - we wish to have a private conversation.'

'Certainly.'

Chandra switched off sound and vision inputs to the main console. As far as this part of the ship was concerned, Hal was now deaf and blind.

'Well, what was all that about?' demanded Vasili Orlov.

'It means,' said Chandra, carefully and precisely, 'that I have erased all Hal's memories, beginning at the moment when the trouble started.'

'That sounds quite a feat,' marvelled Sasha. 'How did you do it?'

'I am afraid it would take me longer to explain than it did to carry out the operation.'

'Chandra, I am a computer expert - though not in the same class as you and Nikolai. The 9000 series uses holographic memories, doesn't it? So you couldn't have used a simple chronological erasure. It must have been some kind of tapeworm, homing on selected words and concepts?'

'Tapeworm?' said Katerina over the ship's intercom. 'I thought that was my department - though I'm glad to say I've never seen one of the beastly things outside a jar of alcohol. What are you talking about?'

'Computer jargon, Katerina. In the old days - the very old days - they really did use magnetic tape. And it's possible to construct a program that can be fed into a system to hunt down and destroy - eat, if you like - any desired memories. 'Can't you do the same sort of thing to human beings, by hypnosis?'

'Yes, but it can always be reversed. We never really forget anything. We only think we do.'

'A computer doesn't work that way. When it's told to forget something, it does. The information is completely erased.'

'So Hal has absolutely no memory of his... misbehaviour?'

'I cannot be a hundred per cent certain of that,' answered Chandra. 'There may be some memories that were in transit from one address to another when the... tapeworm was making its search. But this is very unlikely.'

'Fascinating,' said Tanya, after everyone had thought this over in silence for some time. 'But the much more important question is: Can he be relied upon in future?'

Before Chandra could answer, Floyd anticipated him.

'The same set of circumstances can never arise again; I can promise you that. The whole trouble started because it's difficult to explain Security to a computer.'

'Or to human beings,' muttered Curnow, not very sotto voce.

'I hope you're right,' said Tanya, without much conviction. 'What's the next step, Chandra?'

'Nothing so tricky - merely long and tedious. Now we have to program him to initiate the Jupiter escape sequence - and to bring Discovery home. Three years after we've got back on our high-speed orbit.'

26

Probation

To: Victor Millson, Chairman, National Council on Astronautics,
Washington

From: Heywood Floyd, aboard USSC Discovery

Subject: Malfunction of onboard computer HAL 9000

Classification: SECRET

Dr Chandrasegarampillai (hereinafter referred to as Dr C.) has now completed his preliminary examination of Hal. He has restored all missing modules and the computer appears to be fully operational. Details of Dr C.'s actions and conclusions will be found in the report he and Dr Ternovsky will submit shortly.

Meanwhile you have asked me to summarize them in non-technical terms for the benefit of the Council - especially the new members who will not be familiar with the background. Frankly, I doubt my ability to do this; as you know, I am not a computer specialist. But I will do my best.

The problem was apparently caused by a conflict between Hal's basic instructions and the requirements of Security. By direct Presidential order, the existence of TMA-1 was kept a complete secret. Only those with a need to know were permitted access to the information.

Discovery's mission to Jupiter was already in the advanced planning stage when TMA-1 was excavated, and radiated its signal to that planet. As the function of the prime crew (Bowman, Poole) was merely to get the vessel to its destination, it was decided that they should not be informed of its new objective. By training the investigative team (Kaminski, Hunter, Whitehead) separately, and placing them in hibernation before the voyage began, it was felt that a much higher degree of security would be attained, as the danger of leaks (accidental or otherwise) would be greatly reduced.

I would like to remind you that, at the time (my memorandum NCA 342/23/TOP SECRET of 01.04.03) I pointed out several objections to this policy. However, they were overruled at a higher level.

As Hal was capable of operating the ship without human assistance, it was also decided that he should be programmed to carry out the mission autonomously in the event of the crew's being incapacitated or killed. He was therefore given full knowledge of its objectives, but was not permitted to reveal them to Bowman or Poole.

This situation conflicted with the purpose for which Hal had been designed - the accurate processing of information without distortion or concealment. As a result, Hal developed what would be called, in human terms, a psychosis - specifically, schizophrenia. Dr C. informs me that, in technical terminology, Hal became trapped in a Hofstadter-Moebius loop, a situation apparently not uncommon among advanced computers with autonomous goal-seeking programs. He suggests that for further information you contact Professor Hofstadter himself.

To put it crudely (if I understand Dr C.) Hal was faced with an intolerable dilemma, and so developed paranoiac symptoms that were directed against those monitoring his performance back on Earth. He accordingly attempted to break the radio link with Mission Control, first by reporting a (non-existent) fault in the AE 35 antenna unit.

This involved him not only in a direct lie - which must have aggravated his psychosis still further - but also in a confrontation with the crew. Presumably (we can only guess at this, of course) he decided that the only way out of the situation was to eliminate his human colleagues - which he very nearly succeeded in doing. Looking at the matter purely objectively, it would have been interesting to see what would have happened had he continued the mission alone, without man-made 'interference'.

This is virtually all I have been able to learn from Dr C.; I do not like to question him further, as he is working to the point of exhaustion. But even allowing for this fact, I must frankly state (and please keep this absolutely confidential) that Dr C. is not always as cooperative as he should be. He adopts a defensive attitude toward Hal, which sometimes makes it extremely difficult to discuss the subject. Even Dr Ternovsky, who might have been expected to be a little more independent, often appears to share this viewpoint.

However, the only really important question is: Can Hal be relied upon in the future? Dr C., of course, has no doubts on the matter. He claims to have obliterated all the computer's memories of the traumatic events leading up to the disconnection. Nor does he believe that Hal can suffer from anything remotely analogous to the human sense of guilt.

In any case, it seems impossible that the situation that caused the original problem can ever arise again. Although Hal suffers from a number of peculiarities, they are not of a nature that would cause any apprehension; they are merely minor annoyances, some of them even amusing. And as you know - but Dr C. does not - I have taken steps that will give us complete control as a last resort.

To sum up: The rehabilitation of HAL 9000 is proceeding satisfactorily. One might even say that he is on probation.

I wonder if he knows it.

Interlude: True Confessions

The human mind has an astonishing capacity to adapt; after a while, even the incredible becomes commonplace. There were times when the crew of Leonov switched off their surroundings, perhaps in an unconscious move to preserve sanity.

Dr Heywood Floyd often thought that, on such occasions, Walter Curnow worked a little too hard at being the life and soul of the party. And though he triggered what Sasha Kovalev later called the 'True Confessions' episode, he certainly had not planned anything of the sort. It arose spontaneously when he voiced the universal dissatisfaction with almost all aspects of zero-gravity plumbing.

'If I could have one wish granted,' he exclaimed during the daily Six O'Clock Soviet, 'it would be to soak in a nice foaming bathtub, scented with essence of pine and with just my nose above the waterline.'

When the murmurs of assent and sighs of frustrated desire had died away, Katerina Rudenko took up the challenge.

'How splendidly decadent, Walter,' she beamed at him with cheerful disapproval. 'It makes you sound like a Roman emperor. If I were back on Earth, I'd like something more active.'

'Such as?'

'Umm... Am I allowed to go back in time as well?'

'If you like.'

'When I was a girl, I used to go for holidays to a collective farm in Georgia. There was a beautiful palomino stallion, bought by the director out of the money he'd made on the local black market. He was an old scoundrel, but I loved him - and he used to let me gallop Alexander all over the countryside. I might have been killed - but that's the memory that brings Earth back to me, more than anything else.'

There was a moment of thoughtful silence; then Curnow asked, 'Any other volunteers?'

Everyone seemed so lost in their own memories that the game might have ended there, had not Maxim Brailovsky started it off again.

'I'd like to be diving - that was just about my favourite hobby, when I had time for one - and I was glad I could keep it up through my cosmonaut training. I've dived off Pacific atolls, the Great Barrier Reef, the Red Sea - coral reefs are the most beautiful places in the world. Yet the experience I remember best was in quite a different place - one of the Japanese kelp forests. It was like an underwater cathedral, with sunlight slanting through those enormous leaves. Mysterious... magical. I've never been back; perhaps it wouldn't be the same the next time. But I'd like to try.'

'Fine,' said Walter, who as usual had appointed himself master of ceremonies. 'Who's next?'

'I'll give you a quick answer,' said Tanya Orlova. 'The Bolshoi - Swan Lake. But Vasili won't agree. He hates ballet.'

'That makes two of us. Anyway, what would you select, Vasili?'

'I was going to say diving, but Max beat me to it. So I'll go in the opposite direction - gliding. Soaring through the clouds on a summer day, in complete silence. Well, not quite complete - the airflow over the wing

can get noisy, especially when you're banking. That's the way to enjoy Earth- like a bird.'

'Zenia?'

'Easy. Skiing in the Pamirs. I love snow.'

'And you, Chandra?'

The atmosphere changed noticeably when Walter put the question. After all this time, Chandra was still a stranger - perfectly polite, even courteous, but never revealing himself.

'When I was a boy,' he said slowly, 'my grandfather took me on a pilgrimage to Varanasi - Benares. If you've never been there, I'm afraid you won't understand. To me - to many Indians even nowadays, whatever their religion - it's the centre of the world. One day I plan to go back.'

'And you, Nikolai?'

'Well, we've had the sea and sky. I'd like to combine both. My favourite sport used to be wind-surfing. I'm afraid I'm too old for it now - but I'd like to find out.'

'That only leaves you, Woody. What's your choice?'

Floyd did not even stop to think; his spontaneous answer surprised himself as much as the others.

'I don't mind where on Earth I am - as long as I'm with my little son.'

After that, there was no more to be said. The session was over.

Frustration

'You've seen all the technical reports, Dimitri, so you'll understand our frustration. We've learned nothing new from all our tests and measurements. Zagadka just sits there, filling half the sky, ignoring us completely.

'Yet it can't be inert - an abandoned space derelict. Vasili has pointed out that it must be taking some positive action, to remain here at the unstable libration point. Otherwise it would have drifted away ages ago, just as Discovery did, and crashed into Io.

'So what do we do next? We wouldn't have nuclear explosives on board, would we, in contravention of UN '08, para 3? I'm only joking.

'Now that we're under less pressure, and the launch window for the homeward trip is still weeks away, there's a distinct feeling of boredom, as well as frustration. Don't laugh - I can imagine how that sounds to you, back in Moscow. How could any intelligent person get bored out here, surrounded by the greatest marvels human eyes have ever seen?

'Yet there's no doubt of it. Morale isn't what it was. Until now, we've all been disgustingly healthy. Now almost everyone has a minor cold, or an upset stomach, or a scratch that won't heal despite all of Katerina's pills and powders. She's given up now, and just swears at us.

'Sasha has helped to keep us amused with a series of bulletins on the ship's bulletin board. Their theme is: **STAMP OUT RUSSLISH!** and he lists horrid mixtures of both languages he claims to have overheard, wrong uses of words, and so forth. We'll all need linguistic decontamination when we get home; several times I've come across your countrymen

chatting in English without even being aware of it, lapsing into their native tongue only for difficult words. The other day I caught myself talking Russian to Walter Curnow - and neither of us noticed for several minutes.

'There was one bit of unscheduled activity the other day that will tell you something about our state of mind. The fire alarm went off in the middle of the night, triggered by one of the smoke detectors.

'Well, it turned out that Chandra had smuggled some of his lethal cigars aboard, and couldn't resist temptation anymore. He was smoking one in the toilet, like a guilty schoolboy.

'Of course, he was horribly embarrassed; everyone else thought it hysterically funny, after the initial panic. You know the way some perfectly trivial joke, which doesn't mean a thing to outsiders, can sweep through a group of otherwise intelligent people and reduce them to helpless laughter. One had only to pretend to light a cigar for the next few days, and everybody would go to pieces.

'What makes it even more ridiculous is that no one would have minded in the least if Chandra had just gone into an airlock, or switched off the smoke detector. But he was too shy to admit that he had such a human weakness; so now he spends even more of his time communing with Hal.'

Floyd pressed the PAUSE button and stopped the recording. Perhaps it was not fair to make fun of Chandra, tempting though it often was. All sorts of little quirks of personality had surfaced during the last few weeks; there had even been some bad quarrels, for no obvious reason. And for that matter, what of his own behaviour? Had that always been above criticism?

He was still not sure if he had handled Curnow properly. Though he did not suppose that he would ever really like the big engineer, or enjoy the sound of his slightly too-loud voice, Floyd's attitude toward him had changed from mere tolerance to respectful admiration. The Russians

adored him, not least because his rendering of such favourites as 'Polyushko Polye' often reduced them to tears. And in one case, Floyd felt that the adoration had gone a little too far.

'Walter,' he had begun cautiously, 'I'm not sure if it's my business, but there's a personal matter I'd like to raise with you...'

'When someone says it's not his business, he's usually right. What's the problem?'

'To be blunt, your behaviour with Max.'

There was a frigid silence, which Floyd occupied with a careful inspection of the poor paintjob on the opposite wall. Then Curnow replied, in a soft yet implacable voice: 'I was under the distinct impression that he was more than eighteen.'

'Don't confuse the issue. And frankly, it's not Max I'm concerned about. It's Zenia.'

Curnow's lips parted in unconcealed surprise. 'Zenia? What's she got to do with it?'

'For an intelligent man, you're often singularly unobservant - even obtuse. Surely you realize that she's in love with Max. Haven't you noticed the way she looks, when you put your arm around him?'

Floyd had never imagined that he would see Curnow looking abashed, but the blow seemed to have struck home.

'Zenia? I thought everyone was joking - she's such a quiet little mouse. And everyone's in love with Max, after their fashion - even Catherine the Great. Still... um, I guess I should be more careful. At least while Zenia's around.'

There was a prolonged silence while the social temperature rose back to normal. Then, obviously to show that there was no ill feeling, Curnow added in a conversational tone: 'You know, I've often wondered about Zenia, Somebody did a marvellous job of plastic surgery on her face, but they couldn't repair all the damage. The skin's too tight, and I don't think I've ever seen her laugh properly. Maybe that's why I've avoided looking at her - would you credit me with so much aesthetic sensitivity, Heywood?'

The deliberately formal 'Heywood' signalled good-natured needling rather than hostility, and Floyd allowed himself to relax.

'I can satisfy some of your curiosity - Washington finally got hold of the facts. It seems she was in a bad air crash and was lucky to recover from her burns. There's no mystery, as far as we can tell, but Aeroflot isn't supposed to have accidents.'

'Poor girl. I'm surprised they let her go into space, but I suppose she was the only qualified person available when Irma eliminated herself. I'm sorry for her; apart from the injuries, the psychological shock must have been terrible.'

'I'm sure it was; but she's obviously made a full recovery.' You're not telling the whole truth, said Floyd to himself, and you never will. After their encounter on the approach to Jupiter, there would always be a secret bond between them - not of love, but of tenderness, which is often more enduring.

He found himself suddenly and unexpectedly grateful to Curnow; the other was obviously surprised at his concern for Zenia, but had not attempted to exploit it in his own defence.

And if he had, would it have been unfair? Now, days later, Floyd was beginning to wonder if his own motives were altogether admirable. For his part, Curnow had certainly kept his promise; indeed, if one did not know

better, one might have imagined that he was deliberately ignoring Max - at least while Zenia was around. And he treated her with much greater kindness; indeed, there were occasions when he had even succeeded in making her laugh out loud.

So the intervention had been worthwhile, whatever the impulse behind it. Even if, as Floyd sometimes ruefully suspected, it was no more than the secret envy that normal homo or heterosexuals feel, if completely honest with themselves, toward cheerfully well-adjusted polymorphs.

His finger crept back toward the recorder, but the train of thought had been broken. Inevitably, images of his own home and family came crowding into his mind. He closed his eyes, and memory recalled the climax of Christopher's birthday party - the child blowing out the three candles on the cake, less than twenty-four hours ago but almost a billion kilometres away. He had played the video back so often that now he knew the scene by heart.

And how often had Caroline played his messages to Chris, so that the boy would not forget his father - or view him as a stranger when he returned after missing yet another birthday? He was almost afraid to ask.

Yet he could not blame Caroline. To him, only a few weeks would have passed before they met again. But she would have aged more than two years while he was in his dreamless sleep between the worlds. That was a long time to be a young widow, even a temporary one.

I wonder if I'm coming down with one of the shipboard maladies, Floyd thought; he had seldom felt such a sense of frustration, even of failure. I may have lost my family, across the gulfs of time and space, all to no purpose. For I have achieved nothing; even though I have reached my goal, it remains a blank, impenetrable wall of total darkness.

And yet - David Bowman had once cried: 'My God! It's full of stars!'

29

Emergence

Sasha's latest edict read:

RUSSLISH BULLETIN #8

Subject: Tovanshch (tovarish)

To our American guests:

Frankly, pals, I can't remember when I was last addressed by this term. To any twenty-first century Russian, it's way back there with the battleship Potemkin - a reminder of cloth caps and red flags and Vladimir Ilich haranguing the workers from the steps of railway carriages

Ever since I was a kid it's been bratets or druzhok- take your choice, you're welcome.

Comrade Kovalev

Floyd was still chuckling over this notice when Vasili Orlov joined him as he floated through the lounge/observation deck on his way to the bridge.

'What amazes me, tovarishch, is that Sasha ever found time to study anything besides engineering physics. Yet he's always quoting poems and plays I don't even know, and he speaks better English than - well, Walter.'

'Because he switched to science, Sasha is - what do you say - the black sheep of the family. His father was a professor of English at Novosibirsk. Russian was only allowed in the house Monday to Wednesday; Thursday to Saturday it was English.'

'And Sundays?'

'Oh, French or German, alternate weeks.'

'Now I know exactly what you mean by nekulturny; fits me like a glove. Does Sasha feel guilty about his... defection? And with such a background, why did he ever become an engineer?'

'At Novosibirsk, you soon learn who are the serfs and who are the aristocrats. Sasha was an ambitious young man, as well as a brilliant one.'

'Just like you, Vasili.'

'Et tu, Brute! You see, I can quote Shakespeare as well - Bozhe moi! - what was that?'

Floyd was unlucky; he was floating with his back to the observation window, and saw nothing at all. When he twisted around, seconds later, there was only the familiar view of Big Brother, bisecting the giant disk of Jupiter, just as it had done ever since their arrival.

But to Vasili, for a moment that would be imprinted on his memory forever, that sharp-edged outline held a completely different, and wholly impossible, scene. It was as if a window had suddenly been opened onto another universe.

The vision lasted for less than a second, before his involuntary blink reflex cut it off. He was looking into a field not of stars, but of suns, as if into the crowded heart of a galaxy, or the core of a globular cluster. In that moment, Vasili Orlov lost forever the skies of Earth. From now on they would seem intolerably empty; even mighty Orion and glorious Scorpio would be scarcely noticeable patterns of feeble sparks, not worthy of a second glance.

When he dared to open his eyes again, it was all gone. No - not completely. At the very centre of the now-restored ebon rectangle, a faint star was still shining.

But a star did not move as one watched. Orlov blinked again, to clear his watering eyes. Yes, the movement was real; he was not imagining it.

A meteor? It was some indication of Chief Scientist Vasili Orlov's state of shock that several seconds passed before he remembered that meteors were impossible in airless space.

Then it blurred suddenly into a streak of light, and within a few heartbeats had vanished beyond the edge of Jupiter. By this time, Vasili had recovered his wits and was once more the cool, dispassionate observer.

Already he had a good estimate of the object's trajectory. There could be no doubt; it was aimed directly at Earth.



**A CHILD OF
THE STARS**

Homecoming

It was as if he had awakened from a dream - or a dream within a dream. The gate between the stars had brought him back to the world of men, but no longer as a man.

How long had he been away? A whole lifetime... no, two lifetimes; one forward, one in reverse.

As David Bowman, commander and last surviving crew member of United States Spaceship Discovery, he had been caught in a gigantic trap, set three million years ago and triggered to respond only at the right time, and to the right stimulus. He had fallen through it, from one universe to another, meeting wonders some of which he now understood, others which he might never comprehend.

He had raced at ever-accelerating speed, down infinite corridors of light, until he had outraced light itself. That, he knew, was impossible; but now he also knew how it could be done. As Einstein had rightly said, the Good Lord was subtle, but never malicious.

He had passed through a cosmic switching system - a Grand Central Station of the galaxies - and emerged, protected from its fury by unknown forces, close to the surface of a giant red star.

There he had witnessed the paradox of sunrise on the face of a sun, when the dying star's brilliant white dwarf companion had climbed into its sky - a searing apparition, drawing a tidal wave of fire beneath it. He had felt no fear, but only wonder, even when his space pod had carried him

down into the inferno below... to arrive, beyond all reason, in a beautifully appointed hotel suite containing nothing that was not wholly familiar. However, much of it was fake; the books on the shelves were dummies, the cereal boxes and the cans of beer in the icebox - though they bore famous labels - all contained the same bland food with a texture like bread but a taste that was almost anything he cared to imagine.

He had quickly realized that he was a specimen in a cosmic zoo, his cage carefully recreated from the images in old television programmes. And he wondered when his keepers would appear, and in what physical form.

How foolish that expectation had been! He knew now that one might as well hope to see the wind, or speculate about the true shape of fire.

Then exhaustion of mind and body had overwhelmed him. For the last time, David Bowman slept.

It was a strange sleep, for he was not wholly unconscious. Like a fog creeping through a forest, something invaded his mind. He sensed it only dimly, for the full impact would have destroyed him as swiftly and surely as the fires raging around him. Beneath its dispassionate scrutiny, he felt neither hope nor fear.

Sometimes, in that long sleep, he dreamed he was awake. Years had gone by; once he was looking in a mirror, at a wrinkled face he barely recognized as his own. His body was racing to its dissolution, the hands of the biological clock spinning madly toward a midnight they would never reach. For at the last moment, Time came to a halt - and reversed itself.

The springs of memory were being trapped: in controlled recollection, he was reliving his past, being drained of knowledge and experience as he swept back toward his childhood. But nothing was being lost: all that he had ever been, at every moment of his life, was being transferred to safer

keeping. Even as one David Bowman ceased to exist, another became immortal, passing beyond the necessities of matter.

He was an embryo god, not yet ready to be born. For ages he floated in limbo, knowing what he had been, but not what he had become. He was still in a state of flux -somewhere between chrysalis and butterfly. Or perhaps only between caterpillar and chrysalis.

And then, the stasis was broken: Time re-entered his little world. The black, rectangular slab that suddenly appeared before him was like an old friend.

He had seen it on the Moon; he had encountered it in orbit around Jupiter; and he knew, somehow, that his ancestors had met it long ago. Though it held still unfathomed secrets, it was no longer a total mystery; some of its powers he now understood.

He realized that it was not one, but multitudes; and that whatever measuring instruments might say, it was always the same size - as large as necessary.

How obvious, now, was that mathematical ratio of its sides, the quadratic sequence 1:4:9! And how naive to have imagined that the series ended there, in only three dimensions!

Even as his mind focused upon these geometrical simplicities, the empty rectangle filled with stars. The hotel suite - if indeed it had ever really existed - dissolved back into the mind of its creator; and there before him was the luminous whirlpool of the Galaxy.

It might have been some beautiful, incredibly detailed model, embedded in a block of plastic. But it was the reality, now grasped by him as a whole with senses more subtle than vision. If he wished, he could focus his attention upon any one of its hundred billion stars.

Here he was, adrift in this great river of suns, halfway between the banked fires of the galactic core and the lonely, scattered sentinel stars of the rim. And there was his origin, on the far side of this chasm in the sky, this serpentine band of darkness, empty of all stars. He knew that this formless chaos, visible only by the glow that limned its edges from fire mists far beyond, was the still unused stuff of creation, the raw material of evolutions yet to be. Here, Time had not yet begun; not until the suns that now burned were long since dead would light and life reshape this void.

Unwittingly, he had crossed it once: now, far better prepared, though still wholly ignorant of the impulse that drove him, he must cross it again.

The Galaxy burst forth from the mental frame in which he had enclosed it: stars and nebulae poured past him in an illusion of infinite speed. Phantom suns exploded and fell behind as he slipped like a shadow through their cores.

The stars were thinning out, the glare of the Milky Way dimming into a pale ghost of the glory he had known - and might one day know again. He was back in the space that men called real, at the very point he had left it, seconds or centuries ago.

He was vividly aware of his surroundings, and far more conscious than in that earlier existence of myriad sensory inputs from the external world. He could focus upon any one of them, and scrutinize it in virtually limitless detail, until he confronted the fundamental, granular structure of time and space, below which there was only chaos.

And he could move, though he did not know how. But had he ever really known that, even when he possessed a body? The chain of command from brain to limb was a mystery to which he had never given any thought.

An effort of will, and the spectrum of that nearby star shifted toward the blue, by precisely the amount he wished. He was falling toward it at a

large fraction of the speed of light: though he could go faster if he desired, he was in no hurry. There was still much information to be processed, much to be considered... and much more to be won. That, he knew, was his present goal; but he also knew that it was only part of some far wider plan, to be revealed in due course.

He gave no thought to the gateway between universes dwindling so swiftly behind him, or to the anxious entities gathered around it in their primitive spacecraft. They were part of his memories; but stronger ones were calling him now, calling him home to the world he had never thought to see again.

He could hear its myriad voices, growing louder and louder - as it too was growing, from a star almost lost against the Sun's outstretched corona, to a slim crescent, and finally to a glorious blue-white disk.

They knew that he was coming. Down there on that crowded globe, the alarms would be flashing across the radar screens, the great tracking telescopes would be searching the skies - and history as men had known it would be drawing to a close.

He became aware that a thousand kilometres below a slumbering cargo of death had awakened, and was stirring in its orbit. The feeble energies it contained were no possible menace to him; indeed, he could profitably use them.

He entered the maze of circuitry, and swiftly traced the way to its lethal core. Most of the branchings could be ignored; they were blind alleys, devised for protection. Beneath his scrutiny, their purpose was childishly simple; it was easy to bypass them all.

Now there was a single last barrier - a crude but effective mechanical relay, holding apart two contacts. Until they were closed, there would be no power to activate the final sequence.

He put forth his will - and, for the first time, knew failure and frustration. The few grams of the microswitch would not budge. He was still a creature of pure energy; as yet, the world of inert matter was beyond his grasp. Well, there was a simple answer to that.

He still had much to learn. The current pulse he induced in the relay was so powerful that it almost melted the coil, before it could operate the trigger mechanism.

The microseconds ticked slowly by. It was interesting to observe the explosive lenses focus their energies, like the feeble match that ignites a powder train, which in turn -

The megatons flowered in a silent detonation that brought a brief, false dawn to half the sleeping world. Like a phoenix rising from the flames, he absorbed what he needed, and discarded the rest. Far below, the shield of the atmosphere, which protected the planet from so many hazards, absorbed the most dangerous of the radiation. But there would be some unlucky men and animals who would never see again.

In the aftermath of the explosion, it seemed as if the Earth was struck dumb. The babble of the short and medium waves was completely silenced, reflected back by the suddenly enhanced ionosphere. Only the microwaves still sliced through the invisible and slowly dissolving mirror that now surrounded the planet, and most of these were too tightly beamed for him to receive them. A few high-powered radars were still focused upon him, but that was a matter of no importance. He did not even bother to neutralize them as he could easily have done. And if any more bombs were to come his way, he would treat them with equal indifference. For the present, he had all the energy he needed.

And now he was descending, in great sweeping spirals, toward the lost landscape of his childhood.

Disneyville

A fin-de-siecle philosopher had once remarked - and been roundly denounced for his pains - that Walter Elias Disney had contributed more to genuine human happiness than all the religious teachers in history. Now, half a century after the artist's death, his dreams were still proliferating across the Florida landscape.

When it had opened in the early 1980s, his Experimental Prototype Community of Tomorrow had been a showcase for new technologies and modes of living. But as its founder had realized, EPCOT would only fulfil its purpose when some of its vast acreage was a genuine, living town, occupied by people who called it home. That process had taken the remainder of the century; now the residential area had twenty thousand inhabitants and had, inevitably, become popularly known as Disneyville.

Because they could move in only after penetrating a palace guard of WED lawyers, it was not surprising that the average age of the occupants was the highest in any United States community, or that its medical services were the most advanced in the world. Some of them, indeed, could hardly have been conceived, still less created, in any other place.

The apartment had been carefully designed not to look like a hospital suite, and only a few unusual fittings would have betrayed its purpose. The bed was scarcely knee-high, so that the danger of falls was minimized: it could, however, be raised and tilted for the convenience of the nurses. The bathroom tub was sunk into the floor, and had a built-in seat as well as handrails, so that even the elderly or infirm could get in and out of it

easily. The floor was thickly carpeted, but there were no rugs over which one could trip, or sharp corners that might cause injuries. Other details were less obvious - and the TV camera was so well concealed that no one would have suspected its presence.

There were few personal touches - a pile of old books in one corner, and a framed front page of one of the last printed issues of the New York Times proclaiming: US SPACESHIP LEAVES FOR JUPITER. Close to this were two photographs, one showing a boy in his late teens; the other, a considerably older man wearing astronaut's uniform.

Though the frail, grey-haired woman watching the domestic comedy unfolding on the TV panel was not yet seventy, she looked much older. From time to time she chuckled appreciatively at some joke from the screen, but she kept glancing at the door as if expecting a visitor. And when she did so, she took a firmer grasp on the walking stick propped against her chair.

Yet she was distracted by a moment of TV drama when the door finally opened, and she looked around with a guilty start as the little service trolley rolled into the room, followed closely by a uniformed nurse.

'Time for lunch, Jessie,' called the nurse: 'We've got something very nice for you today.'

'Don't want any lunch.'

'It will make you feel a lot better.'

'I won't eat until you tell me what it is.'

'Why won't you eat it?'

'I'm not hungry. Are you ever hungry?' she added slyly.

The robot food trolley came to a halt beside the chair, and the transport covers opened up to reveal the dishes. Throughout, the nurse never touched anything, not even the controls on the trolley. She now stood motionless, with a rather fixed smile, looking at her difficult patient.

In the monitor room fifty metres away, the medical technician said to the doctor: 'Now watch this.'

Jessie's gnarled hand lifted the walking stick; then, with surprising speed, she swept it in a short arc toward the nurse's legs.

The nurse took no notice whatsoever, even when the stick sliced right through her. Instead, she remarked soothingly, 'Now, doesn't that look nice? Eat it up, dear.'

A cunning smile spread across Jessie's face, but she obeyed instructions. In a moment, she was eating heartily.

'You see?' said the technician. 'She knows perfectly well what's going on. She's a lot brighter than she pretends to be, most of the time.'

'And she's the first?'

'Yes. All the others believe that really is Nurse Williams, bringing their meals.'

'Well, I don't think it matters. Look how pleased she is, just because she's outsmarted us. She's eating her food, which is the purpose of the exercise. But we must warn the nurses - all of them, not just Williams.'

'Why - oh, of course. The next time it may not be a hologram - and then think of the lawsuits we'll be facing from our battered staff.'

Crystal Spring

The Indians, and the Cajun settlers who had moved here from Louisiana, said that Crystal Spring was bottomless. That, of course, was nonsense, and surely even they could not believe it. One had only to put on a face mask and swim out a few strokes - and there, clearly visible, was the little cave from which the incredibly pure water flowed with the slender green weeds undulating around it. And peering up through them, the eyes of the Monster.

Two dark circles, side by side - even though they never moved, what else could they be? That lurking presence gave an added excitement to every swim; one day the Monster would come rushing up from its lair, scattering the fish in its hunt for larger prey. Never would Bobby or David admit that nothing more dangerous than an abandoned, and doubtless stolen, bicycle lay half buried among the water weeds, a hundred metres down.

That depth was hard to believe, even after line and sinker had established it beyond argument. Bobby, the older and better diver, had been perhaps a tenth of the way down, and had reported that the bottom looked just as far away as ever.

But now the Crystal Spring was about to reveal its secrets; perhaps the legend of the Confederate treasure was true, despite the scorn of all the local historians. At the very least, they might endear themselves to the chief of police - always excellent policy - by recovering a few handguns deposited after recent crimes.

The little air compressor that Bobby had found in the garage junk heap was now chugging healthily away, after their initial problems of starting it.

Every few seconds it would cough and emit a cloud of blue smoke, but it showed no sign of stopping. 'And even if it does,' said Bobby, 'so what? If the girls in the Underwater Theatre can swim up from fifty metres without their air hoses, so can we. It's perfectly safe.'

In that case, thought Dave fleetingly, why didn't we tell Ma what we were doing, and why did we wait until Dad had gone back to the Cape for the next shuttle launch? But he did not have any real qualms: Bobby always knew best. It must be wonderful to be seventeen, and to know everything. Though he wished he wouldn't spend quite so much time now with that stupid Betty Schultz. True, she was very pretty - but, dammit, she was a girl! It was only with the greatest difficulty that they had been able to get rid of her this morning.

Dave was used to being a guinea pig; that was what younger brothers were for. He adjusted his face mask, put on his flippers, and slid into the crystalline water.

Bobby handed him the air hose with the old scuba mouthpiece they had taped to it. Dave took a breath, and grimaced.

'It tastes horrible.'

'You'll get used to it. In you go - no deeper than that ledge. That's where I'll start adjusting the pressure valve so we don't waste too much air. Come up when I tug the hose.'

Dave slid gently beneath the surface, and into wonderland. It was a peaceful, monochrome world, so different from the coral reefs of the Keys. There were none of the garish colours of the marine environment, where life - animal and vegetable - flaunted itself with all the hues of the rainbow. Here were only delicate shades of blue and green, and fish that looked like fish, not like butterflies.

He flippered slowly down, dragging the hose behind him, pausing to drink from its stream of bubbles whenever he felt the need. The sensation of freedom was so wonderful that he almost forgot the horrible oily taste in his mouth. When he reached the ledge - actually an ancient, waterlogged tree trunk, so overgrown with weeds that it was unrecognizable - he sat down and looked around him.

He could see right across the spring, to the green slopes at the far side of the flooded crater, at least a hundred metres away. There were not many fish around, but a small school went twinkling past like a shower of silver coins in the sunlight streaming down from above.

There was also an old friend stationed, as usual, at the gap where the waters of the spring began their journey to the sea. A small alligator ('but large enough,' Bobby had once said cheerfully. 'He's bigger than I am.') was hanging vertically, without visible means of support, only his nose above the surface. They had never bothered him, and he had never bothered them.

The air hose gave an impatient tug. Dave was happy to go; he had not realized how cold it could get at that hitherto unattainable depth - and he was also feeling distinctly sick. But the hot sunlight soon revived his spirits.

'No problems,' said Bobby expansively. 'Just keep unscrewing the valve so the pressure gauge doesn't drop below the red line.'

'How deep are you going?'

'All the way, if I feel like it.'

Dave did not take that seriously; they both knew about rapture of the depths and nitrogen narcosis. And in any case, the old garden hose was only thirty metres long. That would be plenty for this first experiment.

As he had done so many times before, he watched with envious admiration as his beloved elder brother accepted a new challenge. Swimming as effortlessly as the fish around him, Bobby glided downward into that blue, mysterious universe. He turned once and pointed vigorously to the air hose, making it unmistakably clear that he needed an increased air flow.

Despite the splitting headache that had suddenly come upon him, Dave remembered his duty. He hurried back to the ancient compressor, and opened the control valve to its deadly maximum - fifty parts per million of carbon monoxide.

The last he saw of Bobby was that confidently descending, sunlight-dappled figure passing forever beyond his reach. The wax statue in the funeral parlour was a total stranger, who had nothing to do with Robert Bowman.

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Betty

Why had he come here, returning like an unquiet ghost to the scene of ancient anguish? He had no idea; indeed, he had not been conscious of his destination, until the round eye of Crystal Spring had gazed up at him from the forest below.

He was master of the world, yet he was paralysed by a sense of devastating grief he had not known for years. Time had healed the wound, as it always does; yet it seemed only yesterday that he had stood weeping beside the emerald mirror, seeing only the reflections of the surrounding cypresses with their burden of Spanish moss. What was happening to him?

And now, still without deliberate volition, but as if swept by some gentle current, he was drifting northward, toward the state capital. He was looking for something; what it was, he would not know until he found it.

No one, and no instrument, detected his passage. He was no longer radiating wastefully, but had almost mastered his control of energy, as once he had mastered lost though not forgotten limbs. He sank like a mist into the earthquakeproof vaults, until he found himself among billions of stored memories, and dazzling, flickering networks of electronic thoughts.

This task was more complex than the triggering of a crude nuclear bomb, and took him a little longer. Before he found the information he was seeking, he made one trivial slip, but did not bother to correct it. No one ever understood why, the next month, three hundred Florida taxpayers, all of whose names began with F, received cheques for precisely one dollar. It cost many times the overpayment to straighten matters out, and the baffled computer engineers finally put the blame on a cosmic-ray shower. Which, on the whole, was not so very far from the truth.

In a few milliseconds, he had moved from Tallahassee to 634 South Magnolia Street, Tampa. It was still the same address; he need not have wasted time looking it up.

But then, he had never intended to look it up, until the very moment when he had done so.

After three births and two abortions, Betty Fernandez (née Schultz) was still a beautiful woman. At the moment she was also a very thoughtful one; she was watching a TV programme that brought back memories, bitter and sweet.

It was a News Special, triggered by the mysterious events of the preceding twelve hours, beginning with the warning that Leonov had

beamed back from the moons of Jupiter. Something was heading for Earth; something had - harmlessly - detonated an orbiting nuclear bomb which no one had come forward to claim. That was all, but it was quite enough.

The news commentators had dredged up all the old videotapes - and some of them really were tapes - going back to the once top-secret records showing the discovery of TMA-1 on the Moon. For the fiftieth time, at least, she heard that eerie radio shriek as the monolith greeted the lunar dawn and hurled its message toward Jupiter. And once again she watched the familiar scenes and listened to the old interviews aboard Discovery.

Why was she watching? It was all stored somewhere in the home archives (though she never played it back when José was around). Perhaps she was expecting some newsflash; she did not like to admit, even to herself, how much power the past still held over her emotions.

And there was Dave, as she had expected. It was an old BBC interview, of which she knew almost every word. He was talking about Hal, trying to decide whether the computer was self-conscious or not.

How young he looked - how different from those last blurred images from the doomed Discovery! And how much like Bobby as she remembered him.

The image wavered as her eyes filled with tears. No - something was wrong with the set, or the channel. Both sound and image were behaving erratically.

Dave's lips were moving, but she could hear nothing. Then his face seemed to dissolve, to melt into blocks of colour. It reformed, blurred again, and then was steady once more. But there was still no sound.

Where had they got this picture! This was not Dave as a man, but as a boy - as she had known him first. He was looking out of the screen almost as if he could see her across the gulf of years.

He smiled; his lips moved.

'Hello, Betty,' he said.

It was not hard to form the words, and to impose them on the currents pulsing in the audio circuits. The real difficulty was to slow down his thoughts to the glacial tempo of the human brain. And then to have to wait an eternity for the answer.

Betty Fernandez was tough; she was also intelligent, and though she had been a housewife for a dozen years, she had not forgotten her training as an electronics serviceperson. This was just another of the medium's countless miracles of simulation; she would accept it now, and worry about the details later.

'Dave,' she answered. 'Dave - is that really you?'

'I am not sure,' replied the image on the screen, in a curiously toneless voice. 'But I remember Dave Bowman, and everything about him.'

'Is he dead?'

Now that was another difficult question.

'His body - yes. But that is no longer important. All that Dave Bowman really was, is still part of me.'

Betty crossed herself - that was a gesture she had learned from José - and whispered:

'You mean - you're a spirit?'

'I do not know a better word.'

'Why have you returned?'

'Ah! Betty - why indeed! I wish you could tell me.'

Yet he knew one answer, for it was appearing on the TV screen. The divorce between body and mind was still far from complete, and not even the most complaisant of the cable networks would have transmitted the blatantly sexual images that were forming there now.

Betty watched for a little while, sometimes smiling, sometimes shocked. Then she turned away, not through shame but sadness - regret for lost delights.

'So it's not true,' she said, 'what they always told us about angels.'

Am I an angel? he wondered. But at least he understood what he was doing there, swept back by the tides of sorrow and desire to a rendezvous with his past. The most powerful emotion he had ever known had been his passion for Betty; the elements of grief and guilt it contained only made it stronger.

She had never told him if he was a better lover than Bobby; that was one question he had never asked, for that would have broken the spell. They had clung to the same illusion, sought in each other's arms (and how young he had been - still only seventeen when it had started, barely two years after the funeral!) a balm for the same wound.

Of course, it could not last, but the experience had left him irrevocably changed. For more than a decade, all his autoerotic fantasies had centred upon Betty; he had never found another woman to compare with her, and long ago had realized that he never would. No one else was haunted by the same beloved ghost.

The images of desire faded from the screen; for a moment, the regular programme broke through, with an incongruous shot of Leonov hanging above Io. Then Dave Bowman's face reappeared. He seemed to be losing control, for its lineaments were wildly unstable. Sometimes he would seem only ten years old - then twenty or thirty -then, incredibly, a wizened mummy whose wrinkled features were a parody of the man she had once known.

'I have one more question before I go. Carlos - you always said he was Jose's son, and I always wondered. What was the truth?'

Betty Fernandez stared for one long, last time into the eyes of the boy she had once loved (he was eighteen again, and for a moment she wished she could see his entire body, not merely his face).

'He was your son, David,' she whispered.

The image faded; the normal service resumed. When, almost an hour later, José Fernandez came quietly into the room, Betty was still staring at the screen.

She did not turn around as he kissed her on the back of the neck.

'You'll never believe this, José.'

'Try me.'

'I've just lied to a ghost.'

Valediction

When the American Institute of Aeronautics and Astronautics published its controversial summary *Fifty Years of UFOs* in 1997, many critics pointed out that unidentified flying objects had been observed for centuries, and that Kenneth Arnold's 'Flying Saucer' sighting of 1947 had countless precedents. People had been seeing strange things in the sky since the dawn of history; but until the mid-twentieth century, UFOs were a random phenomenon of no general interest. After that date, they became a matter of public and scientific concern, and the basis for what could only be called religious beliefs.

The reason was not far to seek; the arrival of the giant rocket and the dawn of the Space Age had turned men's minds to other worlds. Realization that the human race would soon be able to leave the planet of its birth prompted the inevitable questions: Where's everyone, and when may we expect visitors? There was also the hope, though it was seldom spelled out in as many words, that benevolent creatures from the stars might help mankind heal its numerous self-inflicted wounds and save it from future disasters.

Any student of psychology could have predicted that so profound a need would be swiftly satisfied. During the last half of the twentieth century, there were literally thousands of reports of spacecraft sightings from every part of the globe. More than that, there were hundreds of reports of 'close encounters' - actual meetings with extraterrestrial visitors, frequently embellished by tales of celestial joyrides, abductions, and even honeymoons in space. The fact that, over and over again, these were demonstrated to be lies or hallucinations did nothing to deter the faithful.

Men who had been shown cities on the far side of the Moon lost little credibility even when Orbiter surveys and Apollo revealed no artifacts of any kind; ladies who married Venusians were still believed when that planet, sadly, turned out to be hotter than molten lead.

By the time the ALAA published its report no reputable scientist - even among those few who had once espoused the idea- believed that UFOs had any connection with extraterrestrial life or intelligence. Of course, it would never be possible to prove that; any one of those myriad sightings, over the last thousand years, might have been the real thing. But as time went by, and satellite cameras and radars scanning the entire heavens produced no concrete evidence, the general public lost interest in the idea. The cultists, of course, were not discouraged, but kept the faith with their newsletters and books, most of them regurgitating and embellishing old reports long after they had been discredited or exposed.

When the discovery of the Tycho monolith - TMA-I - was finally announced, there was a chorus of 'I told you so's!' It could no longer be denied that there had been visitors to the Moon - and presumably to the Earth as well - a little matter of three million years ago. At once, UFOs infested the heavens again; though it was odd that the three independent national tracking systems, which could locate anything in space larger than a ballpoint pen, were still unable to find them.

Rather quickly, the number of reports dropped down to the 'noise level' once more - the figure that would be expected, merely as a result of the many astronomical, meteorological, and aeronautical phenomena constantly occurring in the skies.

But now it had started all over again. This time, there was no mistake; it was official. A genuine UFO was on its way to Earth.

Sightings were reported within minutes of the warning from Leonov; the first close encounters were only a few hours later. A retired stockbroker, walking his bulldog on the Yorkshire Moors, was astonished

when a disk-shaped craft landed beside him and the occupant - quite human, except for the pointed ears - asked the way to Downing Street. The contactee was so surprised that he was only able to wave his stick in the general direction of Whitehall; conclusive proof of the meeting was provided by the fact that the bulldog now refused to take his food.

Although the stockbroker had no previous history of mental illness, even those who believed him had some difficulty in accepting the next report. This time it was a Basque shepherd on a traditional mission; he was greatly relieved when what he had feared to be border guards turned out to be a couple of cloaked men with piercing eyes, who wanted to know the way to the United Nations Headquarters.

They spoke perfect Basque - an excruciatingly difficult tongue with no affinity to any other known language of mankind. Clearly, the space visitors were remarkable linguists, even if their geography was oddly deficient.

So it went on, case after case. Very few of the contactees were actually lying or insane; most of them sincerely believed their own stories, and retained that belief even under hypnosis. And some were just victims of practical jokes or improbable accidents - like the unlucky amateur archaeologists who found the props that a celebrated science-fiction moviemaker had abandoned in the Tunisian desert almost four decades earlier.

Yet only at the beginning - and at the very end - was any human being genuinely aware of his presence; and that was because he so desired it.

The world was his to explore and examine as he pleased, without restraint or hindrance. No walls could keep him out, no secrets could be hidden from the senses he possessed. At first he believed that he was merely fulfilling old ambitions, by visiting the places he had never seen in

that earlier existence. Not until much later did he realize that his lightning-like sallies across the face of the globe had a deeper purpose.

In some subtle way, he was being used as a probe, sampling every aspect of human affairs. The control was so tenuous that he was barely conscious of it; he was rather like a hunting dog on a leash, allowed to make excursions of his own, yet nevertheless compelled to obey the overriding wishes of his master.

The pyramids, the Grand Canyon, the moon-washed snows of Everest - these were choices of his own. So were some art galleries and concert halls; though he would certainly, on his own initiative, never have endured the whole of the Ring.

Nor would he have visited so many factories, prisons, hospitals, a nasty little war in Asia, a racecourse, a complicated orgy in Beverly Hills, the Oval Room of the White House, the Kremlin archives, the Vatican Library, the sacred Black Stone of the Kaabah at Mecca.

There were also experiences of which he had no clear memory, as if they had been censored - or he was being protected from them by some guardian angel. For example - What was he doing at the Leakey Memorial Museum, in Olduvai Gorge? He had no greater interest in the origin of Man than any other intelligent member of the species *H. sapiens*, and fossils meant nothing to him. Yet the famous skulls, guarded like crown jewels in their display cases, aroused strange echoes in his memory, and an excitement for which he was unable to account. There was a feeling of *déjà vu* stronger than any he had ever known; the place should be familiar - but something was wrong. It was like a house to which one returns after many years, to find that all the furniture has been changed, the walls moved, and even the stairways rebuilt.

It was bleak, hostile terrain, dry and parched. Where were the lush plains and the myriad fleet-footed herbivores that had roamed across them, three million years ago?

Three million years. How had he known that?

No answer came from the echoing silence into which he had thrown the question. But then he saw, once more looming before him, a familiar black rectangular shape. He approached, and a shadowy image appeared in its depths, like a reflection in a pool of ink.

The sad and puzzled eyes that stared back from beneath that hairy, receding forehead looked beyond him into a future they could never see. For he was that future, a hundred thousand generations further down the stream of time.

History had begun there; that at least he now understood. But how - and above all, why - were secrets still withheld from him?

But there was one last duty, and that was hardest of all. He was still sufficiently human to put it off until the very end.

Now what's she up to? the duty nurse asked herself, zooming the TV monitor onto the old lady. She's tried lots of tricks, but this is the first time I've seen her talking to her hearing aid, for goodness sake. I wonder what she's saying?

The microphone was not sensitive enough to pick up the words, but that scarcely seemed to matter. Jessie Bowman had seldom looked so peaceful and content. Though her eyes were closed, her entire face was wreathed in an almost angelic smile while her lips continued to form whispered words.

And then the watcher saw something that she tried hard to forget because to report it would instantly disqualify her in the nursing profession. Slowly and jerkily, the comb lying on the bedside table raised itself in the air as if lifted by clumsy, invisible fingers.

On the first attempt, it missed; then, with obvious difficulty, it began to part the long silver strands, pausing sometimes to disentangle a knot.

Jessie Bowman was not speaking now, but she continued to smile. The comb was moving with more assurance, and no longer in abrupt, uncertain jerks.

How long it lasted the nurse could never be certain. Not until the comb was gently replaced on the table did she recover from her paralysis.

Ten-year-old Dave Bowman had finished the chore which he always hated but which his mother loved. And a David Bowman who was now ageless had gained his first control of obdurate matter.

Jessie Bowman was still smiling when the nurse finally came to investigate. She had been too scared to hurry; but it would have made no difference anyway.

35

Rehabilitation

The uproar of Earth was comfortably muted, across the millions of kilometres of space. Leonov's crew watched, with fascination yet with a certain detachment, the debates in the United Nations, the interviews with distinguished scientists', the theorizing of the news commentators, the matter-of-fact yet wildly conflicting accounts of the UFO contactees. They could contribute nothing to the brouhaha, for they had witnessed no further manifestations of any kind. Zagadka, alias Big Brother, remained as blankly indifferent to their presence as ever. And that was indeed an

ironic situation; they had come all the way from Earth to solve a mystery - and it looked as if the answer might be right back at their starting point.

For the first time, they felt grateful for the slow velocity of light, and the two-hour delay that made live interviews impossible on the Earth-Jupiter circuit. Even so, Floyd was badgered by so many media requests that he finally went on strike. Nothing more remained to be said, and he had said it at least a dozen times.

Besides, there was still much work to be done. Leonov had to be prepared for the long journey home, so that it would be ready to depart immediately when the launch window opened. The timing was not at all critical; even if they missed by a month, that would merely prolong the trip. Chandra, Curnow, and Floyd would not even notice as they slept their way toward the Sun; but the rest of the crew was grimly determined to leave just as soon as the laws of celestial mechanics permitted.

Discovery still posed many problems. The ship had barely sufficient propellant for the return to Earth, even if it left much later than Leonov and flew a minimum-energy orbit - which would take almost three years. And this would be possible only if Hal could be reliably programmed to carry out the mission with no human intervention except long-range monitoring. Without his cooperation, Discovery would have to be abandoned once again.

It had been fascinating - indeed, deeply moving - to watch the steady regrowth of Hal's personality, from brain-damaged child to puzzled adolescent and at length to slightly condescending adult. Although he knew that such anthropomorphic labels were highly misleading, Floyd found it quite impossible to avoid them.

And there were times when he felt that the whole situation had a haunting familiarity. How often he had seen videodramas in which disturbed youngsters were straightened out by all-wise descendants of the

legendary Sigmund Freud! Essentially the same story was being played out in the shadow of Jupiter.

The electronic psychoanalysis had proceeded at a speed totally beyond human comprehension as repair and diagnostic programs flashed through Hal's circuits at billions of bits a second, pinpointing possible malfunctions and correcting them. Though most of these programs had been tested in advance on Hal's twin, SAL 9000, the impossibility of a real-time dialogue between the two computers was a serious handicap. Sometimes hours were wasted when it proved necessary to check back with Earth at a critical point in the therapy.

For despite all Chandra's work, the computer's rehabilitation was still far from complete. Hal exhibited numerous idiosyncrasies and nervous tics, sometimes even ignoring spoken words - though he would always acknowledge keyboard inputs from anyone. In the reverse direction, his outputs were even more eccentric.

There were times when he would give verbal replies, but would not display them visually. At other times he would do both - but refused to print hard copy. He would give no excuses or explanations - not even the stubbornly impenetrable 'I prefer not to' of Melville's autistic scrivener, Bartelby.

However, he was not actively disobedient so much as reluctant, and only where certain tasks were concerned. It was always possible to win his cooperation eventually - 'to talk him out of his sulk', as Curnow put it neatly.

It was not surprising that Dr Chandra was beginning to show the strain. On one celebrated occasion when Max Brailovsky innocently revived an old canard, he almost lost his temper.

'Is it true, Dr Chandra, that you chose the name Hal to be one step ahead of IBM?'

'Utter nonsense! Half of us come from IBM and we've been trying to stamp out that story for years. I thought that by now every intelligent person knew that H-A-L is derived from Heuristic ALgorithmic.'

Afterward, Max swore that he could distinctly hear the capital letters.

In Floyd's private opinion, the odds were at least fifty to one against flying Discovery safely back to Earth. And then Chandra came to him with an extraordinary proposal.

'Dr Floyd, can I have a word with you?'

After all the weeks and shared experiences, Chandra was still as formal as ever - not only to Floyd, but to all the crew. He would not even address the ship's baby, Zenia, without the prefix 'ma'am'.

'Of course, Chandra. What is it?'

'I've virtually completed the programming for the six most probable variations on the Hohmann return orbit. Five have now been run on a simulation, without any problems.'

'Excellent. I'm sure that no one else on Earth - in the Solar System - could have done it.'

'Thank you. However, you know as well as I do that it's impossible to program for every eventuality. Hal may - will - function perfectly, and will be able to handle any reasonable emergency. But all sorts of trivial accidents - minor equipment failures that could be fixed with a screwdriver, broken wires, stuck switches - could leave him helpless and abort the whole mission.'

'You're absolutely right, of course, and it's been worrying me. But what can we do about it?'

'It's really quite simple. I'd like to stay with Discovery.'

Floyd's immediate reaction was that Chandra had gone crazy. On second thoughts, perhaps he was only half crazy. It might indeed make all the difference between success and failure to have a human being - that superb all-purpose trouble-shooting and repair device - aboard Discovery for the long voyage back to Earth. But the objections were completely overwhelming.

'It's an interesting idea,' Floyd answered with extreme caution, 'and I certainly appreciate your enthusiasm. But have you thought of all the problems?' That was a silly thing to say; Chandra would have all the answers already filed away for immediate retrieval.

'You'll be on your own for over three years! Suppose you had an accident or a medical emergency?'

'That's a risk I'm prepared to take.'

'And what about food, water? Leonov doesn't have enough to spare.'

'I've checked Discovery's recycling system; it can be made operational again without too much difficulty. Besides, we Indians can manage on very little.'

It was unusual for Chandra to refer to his origins, or indeed to make any personal statements; his 'true confession' was the only example Floyd could remember. But he did not doubt the claim; Curnow had once remarked that Dr Chandra had the sort of physique that could only be achieved by centuries of starvation. Although it sounded like one of the engineer's unkindest wisecracks, it had been made entirely without malice - indeed, with sympathy; though not, of course, in Chandra's hearing.

'Well, we still have several weeks to decide. I'll think it over and talk to Washington.'

'Thank you; do you mind if I start making the arrangements?'

'Er - not at all, as long as they don't interfere with the existing plans. Remember - Mission Control will have to make the final decision.'

And I know exactly what Mission Control will say. It was madness to expect a man to survive in space for three, years, alone.

But, of course, Chandra had always been alone.

36

Fire in the Deep

Earth was already far behind, and the awesome wonders of the Jovian system were expanding swiftly before him, when he had his revelation.

How could he have been so blind - so stupid! It was as if he had been walking in his sleep; now he was starting to awaken.

Who are you? he cried. What do you want? Why have you done this to me?

There was no answer, yet he was certain that he had been heard. He sensed a... presence, even as a man can tell, though his eyes are tightly shut, that he is in a closed room and not some empty, open space. Around him there was the faint echo of a vast mentality, an implacable will.

He called again into the reverberant silence, and again there was no direct reply - only that sense of watchful companionship. Very well; he would find the answers for himself.

Some were obvious; whoever or whatever they were, they were interested in Mankind. They had tapped and stored his memories, for their own inscrutable purposes. And now they had done the same with his deepest emotions, sometimes with his cooperation, sometimes without.

He did not resent that; indeed, the very processing he had experienced made such childish reactions impossible. He was beyond love and hate and desire and fear - but he had not forgotten them, and could still understand how they ruled the world of which he had once been part. Was that the purpose of the exercise? If so, for what ultimate goal?

He had become a player in a game of gods, and must learn the rules as he went along.

The jagged rocks of the four tiny outer moons, Sinope, Pasiphae, Carme, and Ananke, flickered briefly across his field of consciousness; then came Elara, Lysithea, Himalia, and Leda at half their distance from Jupiter. He ignored them all; now the pock-marked face of Callisto lay ahead.

Once, twice, he orbited the battered globe, larger than Earth's own Moon, while senses of which he had been unaware probed its outer layers of ice and dust. His curiosity was quickly satisfied; the world was a frozen fossil, still bearing the marks of collisions that, aeons ago, must have come close to shattering it. One hemisphere was a giant bull's-eye, a series of concentric rings where solid rock had once flowed in kilometre-high ripples under some ancient hammer blow from space.

Seconds later, he was circling Ganymede. Now there was a far more complex and interesting world; though so near to Callisto, and almost the same size, it presented an utterly different appearance. There were, it was true, numerous craters - but most of them seemed to have been, quite literally, ploughed back into the ground. The most extraordinary feature of the Ganymede landscape was the presence of meandering stripes, built up from scores of parallel furrows a few kilometres apart. This grooved terrain looked as if it had been produced by armies of intoxicated ploughmen, weaving back and forth across the face of the satellite.

In a few revolutions, he saw more of Ganymede than all the space probes ever sent from Earth, and filed away the knowledge for future use. One day it would be important; he was sure of that, though he did not know why - any more than he understood the impulse that was now driving him so purposefully from world to world.

As, presently, it brought him to Europa. Though he was still largely a passive spectator, he was aware now of a rising interest, a focusing of attention - a concentration of will. Even if he was a puppet in the hands of an unseen and uncommunicative master, some of the thoughts of that controlling influence leaked - or were allowed to leak - into his own mind.

The smooth, intricately patterned globe now, rushing toward him bore little resemblance either to Ganymede or Callisto. It looked organic; the network of lines branching and intersecting over its entire surface was uncannily like a world-spanning system of veins and arteries.

The endless ice fields of a frigid waste, far colder than the Antarctic, stretched beneath him. Then, with brief surprise, he saw that he was passing over the wreckage of a spaceship. He recognized it instantly as the ill-fated Tsien, featured in so many of the video newscasts he had analysed. Not now - not now - there would be ample opportunity later.

Then he was through the ice, and into a world as unknown to his controllers as to himself.

It was an ocean world, its hidden waters protected from the vacuum of space by a crust of ice. In most places the ice was kilometres thick, but there were lines of weakness where it had cracked open and torn apart. Then there had been a brief battle between two implacably hostile elements that came into direct contact on no other world in the Solar System. The war between Sea and Space always ended in the same stalemate; the exposed water simultaneously boiled and froze, repairing the armour of ice.

The seas of Europa would have frozen completely solid long ago without the influence of nearby Jupiter. Its gravity continually kneaded the core of the little world; the forces that convulsed Io were working there, though with much less ferocity. As he skimmed across the face of the deep, he saw everywhere the evidence of that tug-of-war between planet and satellite.

And he both heard and felt it, in the continual roar and thunder of submarine earthquakes, the hiss of escaping gases from the interior, the infrasonic pressure waves of avalanches sweeping over the abyssal plains. By comparison with the tumultuous ocean that covered Europa, even the noisy seas of Earth were silent.

He had not lost his sense of wonder, and the first oasis filled him with delighted surprise. It extended for almost a kilometre around a tangled mass of pipes and chimneys deposited by mineral brines gushing from the interior. Out of that natural parody of a Gothic castle, black, scalding liquids pulsed in a slow rhythm, as if driven by the beating of some mighty heart. And, like blood, they were the authentic sign of life itself.

The boiling fluids drove back the deadly cold leaking down from above, and formed an island of warmth on the seabed. Equally important, they brought from Europa's interior all the chemicals of life. There, in an environment where none had expected it, were energy and food, in abundance.

Yet it should have been expected; he remembered that, only a lifetime ago, such fertile oases had been discovered in the deep oceans of Earth. Here they were present on an immensely larger scale, and in far greater variety.

In the tropical zone close to the contorted walls of the 'castle' were delicate, spidery structures that seemed to be the analogy of plants, though almost all were capable of movement. Crawling among these were bizarre slugs and worms, some feeding on the plants, others obtaining their food directly from the mineral-laden waters around them. At greater distances from the source of heat - the submarine fire around which all the creatures warmed themselves - were sturdier, more robust organisms, not unlike crabs or spiders.

Armies of biologists could have spent lifetimes studying that one small oasis. Unlike the Palaeozoic terrestrial seas, it was not a stable environment, so evolution had progressed swiftly here, producing multitudes of fantastic forms. And they were all under indefinite stay of execution; sooner or later, each fountain of life would weaken and die, as the forces that powered it moved their focus elsewhere.

Again and again, in his wanderings across the European seabed, he encountered the evidence of such tragedies. Countless circular areas were littered with the skeletons and mineral-encrusted remains of dead creatures, where entire chapters of evolution had been deleted from the book of life.

He saw huge, empty shells formed like convoluted trumpets as large as a man. There were clams of many shapes - bivalves, and even trivalves. And there were spiral stone patterns, many metres across, which seemed an exact analogy of the beautiful ammonites that disappeared so mysteriously from Earth's oceans at the end of the Cretaceous Period.

Searching, seeking, he moved back and forth over the face of the abyss. Perhaps the greatest of all the wonders he met was a river of incandescent lava, flowing for a hundred kilometres along a sunken valley. The pressure at that depth was so great that the water in contact with the red-hot magma could not flash into steam, and the two liquids coexisted in an uneasy truce.

There, on another world and with alien actors, something like the story of Egypt had been played long before the coming of man. As the Nile had brought life to a narrow ribbon of desert, so this river of warmth had vivified the European deep. Along its banks, in a band never more than two kilometres wide, species after species had evolved and flourished and passed away. And at least one had left a monument behind it.

At first, he thought that it was merely another of the encrustations of mineral salts that surrounded almost all the thermal vents. However, as he came closer, he saw that it was not a natural formation, but a structure created by intelligence. Or perhaps by instinct; on Earth, the termites reared castles that were almost equally imposing, and the web of a spider was more exquisitely designed.

The creatures that had lived there must have been quite small, for the single entrance was only half a metre wide. That entrance - a thick-walled tunnel, made by heaping rocks on top of each other - gave a clue to the builders' intentions. They had reared a fortress, there in the flickering glow not far from the banks of their molten Nile. And then they had vanished.

They could not have left more than a few centuries before. The walls of the fortress, built from irregularly shaped rocks that must have been collected with great labour, were covered with only a thin crust of mineral deposits. One piece of evidence suggested why the stronghold had been abandoned. Part of the roof had fallen in, perhaps owing to the continual earthquakes; and in an underwater environment, a fort without a roof was wide open to an enemy.

He encountered no other sign of intelligence along the river of lava. Once, however, he saw something uncannily like a crawling man - except that it had no eyes and no nostrils, only a huge, toothless mouth that gulped continuously, absorbing nourishment from the liquid medium around it.

Along the narrow band of fertility in the deserts of the deep, whole cultures and even civilizations might have risen and fallen, armies might have marched (or swum) under the command of European Tamberlanes or Napoleons. And the rest of their world would never have known, for all those oases of warmth were as isolated from one another as the planets themselves. The creatures who basked in the glow of the lava river, and fed around the hot vents, could not cross the hostile wilderness between their lonely islands, If they had ever produced historians and philosophers, each culture would have been convinced that it was alone in the Universe.

Yet even the space between the oases was not altogether empty of life; there were hardier creatures who had dared its rigours. Often swimming overhead were the European analogues of fish - streamlined torpedoes, propelled by vertical tails, steered by fins along their bodies. The resemblance to the most successful dwellers in Earth's oceans was inevitable; given the same engineering problems, evolution must produce very similar answers. As witness the dolphin and the shark - superficially almost identical, yet from far distant branches of the tree of life.

There was, however, one very obvious difference between the fish of the European seas and those in terrestrial oceans; they had no gills, for there was hardly a trace of oxygen to be extracted from the waters in which they swam. Like the creatures around Earth's own geothermal vents, their metabolism was based on sulphur compounds, present in abundance in the near-volcanic environment.

And very few had eyes. Apart from the flickering glow of the rare lava outpourings, and occasional bursts of bioluminescence from creatures seeking mates, or hunters questing prey, it was a lightless world.

It was also a doomed one. Not only were its energy sources sporadic and constantly shifting, but the tidal forces that drove them were steadily weakening. Even if they developed true intelligence, the Europeans must perish with the final freezing of their world.

They were trapped between fire and ice.

37

Estrangement

'I'm truly sorry, old friend, to be the bearer of such bad news, but Caroline has asked me, and you know how I feel about you both.

'And I don't think it can be such a surprise. Some of the remarks you've made to me over the last year have hinted at it... and you know how bitter she was when you left Earth.

'No, I don't believe there's anyone else. If there was, she'd have told me... But sooner or later - well, she's an attractive young woman.

'Chris is fine, and of course he doesn't know what's happening. At least he won't be hurt. He's too young to understand, and children are incredibly... elastic? - just a minute, I'll have to key my thesaurus... ah, resilient.

'Now to things that may seem less important to you. Everyone is still trying to explain that bomb detonation as an accident, but of course nobody believes it. Because nothing else has happened, the general

hysteria has died down; we're left with what one of your commentators has called the "looking-over-the-shoulder syndrome".

'And someone has found a hundred-year-old poem that sums up the situation so neatly that everybody's quoting it. It's set in the last days of the Roman Empire, at the gates of a city whose occupants are waiting for invaders to arrive. The emperor and dignitaries are all lined up in their most costly togas, ready with speeches of welcome. The senate has closed, because any laws it passes today will be ignored by the new masters.

'Then, suddenly, a dreadful piece of news arrives from the frontier. There aren't any invaders. The reception committee breaks up in confusion; everyone goes home muttering disappointedly, "Now what will happen to us? Those people were a kind of solution."

'There's just one slight change needed to bring the poem up to date. It's called "Waiting for the Barbarians" - and this time, we are the barbarians. And we don't know what we're waiting for, but it certainly hasn't arrived.

'One other item. Had you heard that Commander Bowman's mother died only a few days after the thing came to Earth? It does seem an odd coincidence, but the people at her nursing home say that she never showed the slightest interest in the news, so it couldn't possibly have affected her.'

Floyd switched off the recording. Dimitri was right; he was not taken by surprise. But that made not the slightest difference; it hurt just as badly.

Yet what else could he have done? If he had refused to go on the mission - as Caroline had so clearly hoped - he would have felt guilty and unfulfilled for the remainder of his life. That would have poisoned his marriage; better this clean break, when physical distance softened the pain of separation. (Or did it? In some ways, it made things worse.) More

important was duty, and the sense of being part of a team devoted to a single goal.

So Jessie Bowman was gone. Perhaps that was another cause for guilt. He had helped to steal her only remaining son, and that must have contributed to her mental breakdown. Inevitably, he was reminded of a discussion that Walter Curnow had started, on that very subject.

'Why did you choose Dave Bowman? He always struck me as a cold fish - not actually unfriendly, but whenever he came into the room, the temperature seemed to drop ten degrees.'

'That was one of the reasons we did select him. He had no close family ties, except for a mother he didn't see very often. So he was the sort of man we could send on a long, open-ended mission.'

'How did he get that way?'

'I suppose the psychologists could tell you. I did see his report, of course, but that was a long time ago. There was something about a brother who was killed - and his father died soon afterward, in an accident on one of the early shuttles. I'm not supposed to tell you this, but it certainly doesn't matter now.'

It didn't matter; but it was interesting. Now Floyd almost envied David Bowman, who had come to that very spot a free man unencumbered by emotional ties with Earth.

No - he was deceiving himself. Even while the pain gripped his heart like a vice, what he felt for David Bowman was not envy, but pity.

Foamscape

The last beast he saw, before he left the oceans of Europa, was much the largest. It closely resembled one of the banyan trees from Earth's tropics, whose scores of trunks allow a single plant to create a small forest sometimes covering hundreds of square metres. The specimen, however, was walking, apparently on a trek between oases. If it was not one of the creatures that had destroyed Tsien, it certainly belonged to a very similar species.

Now he had learned all that he needed to know - or, rather, all that they needed to know. There was one more moon to visit; seconds later, the burning landscape of Io lay below him.

It was as he had expected. Energy and food were there in abundance, but the time was not yet ripe for their union. Around some of the cooler sulphur lakes, the first steps had been taken on the road to life, but before any degree of organization had occurred, all such bravely premature attempts were thrown back into the melting pot. Not until the tidal forces that drove Io's furnaces had lost their power, millions of years later, would there be anything to interest biologists on that seared and sterilized world.

He wasted little time on Io, and none at all on the tiny inner moons that skirted Jupiter's ghostly rings - themselves only pale shadows of the glory that was Saturn's. The greatest of worlds lay before him; he would know it as no man had ever done, or ever would.

The million-kilometre-long tendrils of magnetic force, the sudden explosions of radio waves, the geysers of electrified plasma wider than the

planet Earth- they were as real and clearly visible to him as the clouds banding the planet in multihued glory. He could understand the complex pattern of their interactions, and realized that Jupiter was much more wonderful than anyone had ever guessed.

Even as he fell through the roaring heart of the Great Red Spot, with the lightning of its continent-wide thunderstorms detonating around him, he knew why it had persisted for centuries though it was made of gases far less substantial than those that formed the hurricanes of Earth. The thin scream of hydrogen wind faded as he sank into the calmer depths, and a sleet of waxen snowflakes - some already coalescing into barely palpable mountains of hydrocarbon foam - descended from the heights above. It was already warm enough for liquid water to exist, but there were no oceans there; that purely gaseous environment was too tenuous to support them.

He descended through layer after layer of cloud, until he entered a region of such clarity that even human vision could have scanned an area more than a thousand kilometres across. It was only a minor eddy in the vaster gyre of the Great Red Spot; and it held a secret that men had long guessed, but never proved.

Skirting the foothills of the drifting foam mountains were myriads of small, sharply-defined clouds, all about the same size and patterned with similar red and brown mottlings. They were small only as compared with the inhuman scale of their surroundings; the very least would have covered a fair-sized city.

They were clearly alive, for they were moving with slow deliberation along the flanks of the aerial mountains, browsing off their slopes like colossal sheep. And they were calling to each other in the metre band, their radio voices faint but clear against the cracklings and concussions of Jupiter itself.

Nothing less than living gasbags, they floated in the narrow zone between freezing heights and scorching depths. Narrow, yes - but a domain far larger than all the biosphere of Earth.

They were not alone. Moving swiftly among them were other creatures so small that they could easily have been overlooked. Some of them bore an almost uncanny resemblance to terrestrial aircraft and were of about the same size. But they too were alive - perhaps predators, perhaps parasites, perhaps even herdsmen.

A whole new chapter of evolution, as alien as that which he had glimpsed on Europa, was opening before him. There were jet-propelled torpedoes like the squids of the terrestrial oceans, hunting and devouring the huge gasbags. But the balloons were not defenceless; some of them fought back with electric thunderbolts and with clawed tentacles like kilometre-long chainsaws.

There were even stranger shapes, exploiting almost every possibility of geometry - bizarre, translucent kites, tetrahedra, spheres, polyhedra, tangles of twisted ribbons.

The gigantic plankton of the Jovian atmosphere, they were designed to float like gossamer in the uprising currents, until they had lived long enough to reproduce; then they would be swept down into the depths to be carbonized and recycled in a new generation.

He was searching a world more than a hundred times the area of Earth, and though he saw many wonders, nothing there hinted of intelligence. The radio voices of the great balloons carried only simple messages of warning or of fear. Even the hunters, who might have been expected to develop higher degrees of organization, were like the sharks in Earth's oceans - mindless automata.

And for all its breathtaking size and novelty, the biosphere of Jupiter was a fragile world, a place of mists and foam, of delicate silken threads

and paper-thin tissues spun from the continual snowfall of petrochemicals formed by lightning in the upper atmosphere. Few of its constructs were more substantial than soap bubbles; its most terrifying predators could be torn to shreds by even the feeblest of terrestrial carnivores.

Like Europa on a vastly grander scale, Jupiter was an evolutionary cul-de-sac. Consciousness would never emerge here; even if it did, it would be doomed to a stunted existence. A purely aerial culture might develop, but in an environment where fire was impossible, and solids scarcely existed, it could never even reach the Stone Age.

And now, as he hovered above the centre of a Jovian cyclone merely as large as Africa, he became aware once again of the presence controlling him. Moods and emotions were leaking into his own consciousness, though he could not identify any specific concepts or ideas. It was as if he were listening, outside a closed door, to a debate in progress, and in a language he could not understand. But the muffled sounds clearly conveyed disappointment, then uncertainty, then a sudden determination - though for what purpose he could not tell. Once again, he felt like a pet dog, able to share his master's changing moods but not to comprehend them.

And then the invisible leash was taking him down toward the heart of Jupiter. He was sinking through the clouds, below the level where any form of life was possible.

Soon he was beyond the reach of the last rays from the faint and distant Sun. The pressure and temperature were swiftly mounting; already it was above the boiling point of water, and he passed briefly through a layer of superheated steam. Jupiter was like an onion; he was peeling it away skin by skin, though as yet he had travelled only a fraction of the distance to its core.

Beneath the steam was a witches' brew of petrochemicals - enough to power for a million years all the internal-combustion engines that mankind

had dyer built. It became thicker and denser; then, quite abruptly, it ended at a discontinuity only a few kilometres thick.

Heavier than any rocks on Earth, yet still a liquid, the next shell consisted of silicon and carbon compounds of a complexity that could have provided lifetimes of work for terrestrial chemists. Layer followed layer for thousands of kilometres, but as the temperature rose into the hundreds and then the thousands of degrees, the composition of the various strata became simpler and simpler. Halfway down to the core, it was too hot for chemistry; all compounds were torn apart, and only the basic elements could exist.

Next there came a deep sea of hydrogen - but not hydrogen as it had ever existed for more than a fraction of a second in any laboratory on Earth. This hydrogen was under such enormous pressure that it had become a metal.

He had almost reached the centre of the planet, but Jupiter had one more surprise in store. The thick shell of metallic yet still fluid hydrogen ended abruptly. At last, there was a solid surface, sixty thousand kilometres down.

For ages, the carbon baked out of the chemical reactions far above had been drifting down toward the centre of the planet. There it had gathered, crystallizing at a pressure of millions of atmospheres. And there, by one of Nature's supreme jests, was something very precious to mankind.

The core of Jupiter, forever beyond human reach, was a diamond as big as the Earth.

In the Pod Bay

'Walter - I'm worried about Heywood.'

'I know, Tanya - but what can we do?'

Curnow had never seen Commander Orlova in so indecisive a mood; it made her seem much more appealing, despite his prejudice against small women.

'I'm very fond of him, but that's not the reason. His - I suppose gloom is the best word for it - is making everyone miserable. Leonov has been a happy ship. I want to keep it that way.'

'Why don't you talk to him? He respects you, and I'm sure he'll do his best to snap out of it.'

'I intend to do just that. And if it doesn't work -' 'Well?'

'There's one simple solution. What more can he do on this trip? When we start back for home, he'll be in hibernation anyway. We could always - what do you say, jump the gun on him.'

'Phew - the same dirty trick that Katerina played on me. He'd be mad when he woke up.'

'But also safely back on Earth, and very busy. I'm sure he'd forgive us.'

'I don't think you're serious. Even if I backed you up, Washington would raise hell. Besides, suppose something happened, and we really need him badly? Isn't there a two-week buffer period, before you can revive anyone safely?'

'At Heywood's age, more like a month. Yes, we'd be committed. But what do you think could happen now? He's done the job he was sent for - apart from keeping an eye on us. And I'm sure you've been well briefed about that in some obscure suburb of Virginia or Maryland.'

'I neither confirm nor deny. And frankly, I'm a lousy undercover agent. I talk too much, and I hate Security. I've fought all my life to keep my rating below Restricted. Every time there was danger of being reclassified Confidential or, worse still, Secret, I'd go and create a scandal. Though that's getting very difficult nowadays.'

'Walter, you're incorrupt -'

'Incorrigible?'

'Yes, that's the word I meant. But back to Heywood, please. Would you like to talk to him first?'

'You mean - give him a pep talk? I'd rather help Katerina drive in the needle. Our psychologies are too different. He thinks I'm a loudmouthed clown.'

'Which you often are. But that's only to hide your real feelings. Some of us have evolved the theory that deep down inside you is a really nice person, struggling to get out.'

For once, Curnow was at a loss for words. Finally he mumbled: 'Oh, very well - I'll do my best. But don't expect miracles; my profile gave me Z for tact. Where's he hiding at the moment?'

'In the Pod Bay. He claims he's working on his final report, but I don't believe it. He just wants to get away from us all, and that's the quietest place.'

That was not the reason, though it was indeed an important one. Unlike the carousel, where most of the action aboard Discovery was then taking place, the Pod Bay was a zero-gee environment.

Right at the beginning of the Space Age, men had discovered the euphoria of weightlessness and remembered the freedom they had lost when they left the ancient womb of the sea. Beyond gravity, some of that freedom was regained; with the loss of weight went many of the cares and worries of Earth.

Heywood Floyd had not forgotten his sorrow, but it was more bearable there. When he was able to look at the matter dispassionately, he was surprised at the strength of his reaction to an event not wholly unexpected. More than loss of love was involved, though that was the worst part. The blow had come when he was particularly vulnerable, at the very moment when he was feeling a sense of anticlimax, even futility.

And he knew precisely why. He had achieved all that he had been expected to do, thanks to the skill and cooperation of his colleagues (he was letting them down, he knew, by his present selfishness). If all went well - that litany of the Space Age! - they would return to Earth with a cargo of knowledge that no expedition had ever gathered before, and a few years later even the once-lost Discovery would be restored to her builders.

It was not enough. The overpowering enigma of Big Brother remained out there, only a few kilometres away, mocking all human aspirations and achievements. Just as its analogue on the Moon had done, a decade ago, it had come to life for a moment, then relapsed into stubborn inertness. It was a closed door upon which they had hammered in vain. Only David Bowman, it seemed, had ever found the key.

Perhaps that explained the attraction he felt for the quiet and sometimes even mysterious place. From there - from that now empty launch cradle - Bowman had left on his last mission, through the circular hatchway that led to infinity.

He found the thought exhilarating rather than depressing; certainly it helped to distract him from his personal problems. Nina's vanished twin was part of the history of space exploration; it had travelled, in the words of the hoary old cliché that always evoked a smile yet an acknowledgement of its fundamental truth, 'where no man had gone before...' Where was it now? Would he ever know?

He would sometimes sit for hours in the crowded but not cramped little capsule, trying to collect his thoughts and occasionally dictating notes; the other crew members respected his privacy, and understood the reason for it. They never came near the Pod Bay, and had no need to do so. Its refurbishment was a job for the future, and some other team.

Once or twice, when he had felt really depressed, he found himself thinking: Suppose I ordered Hal to open the Pod Bay doors, and set out along Dave Bowman's trail? Would I be greeted by the miracle he saw and which Vasili glimpsed a few weeks ago? It would solve all my problems...

Even if the thought of Chris did not deter him, there was an excellent reason why so suicidal a move was out of the question. Nina was a very complex piece of equipment; he could no more operate her than fly a fighter aircraft.

He was not meant to be an intrepid explorer: that particular fantasy would remain unrealized.

Walter Curnow had seldom undertaken a mission with more reluctance. He felt genuinely sorry for Floyd, but at the same time a little impatient

with the other's distress. His own emotional life was broad but shallow; he had never put all his eggs in one basket. More than once he had been told that he spread himself too thin, and though he had never regretted it, he was beginning to think it was time to settle down.

He took the shortcut through the carousel control centre, noting that the Maximum Speed Reset Indicator was still flashing idiotically. A major part of his job was deciding when warnings could be ignored, when they could be dealt with at leisure - and when they had to be treated as real emergencies. If he paid equal attention to all the ship's cries for help, he would never get anything done.

He drifted along the narrow corridor that led to the Pod Bay, propelling himself by occasional flicks against the rungs on the tubular wall. The pressure gauge claimed that there was vacuum on the other side of the airlock door, but he knew better. It was a fail-safe situation; he could not have opened the lock if the gauge were telling the truth.

The bay looked empty, now that two of the three pods had long since gone. Only a few emergency lights were operating, and on the far wall one of Hal's fish-eye lenses was regarding him steadily. Curnow waved to it, but did not speak. At Chandra's orders, all audio inputs were still disconnected except for the one that only he used.

Floyd was sitting in the pod with his back to the open hatch, dictating some notes, and he swung slowly around at Curnow's deliberately noisy approach. For a moment the two men regarded each other in silence, then Curnow announced portentously, 'Dr H. Floyd, I bear greetings from our beloved captain. She considers it high time you rejoined the civilized world.'

Floyd gave a wan smile, then a little laugh.

'Please return my compliments. I'm sorry I've been - unsociable. I'll see you all at the next Six O'Clock Soviet.'

Curnow relaxed; his approach had worked. Privately, he considered Floyd something of a stuffed shirt, and had the practical engineer's tolerant contempt for theoretical scientists and bureaucrats. Since Floyd ranked high in both categories, he was an almost irresistible target for Curnow's sometimes peculiar sense of humour. Nevertheless, the two men had grown to respect and even admire each other.

Thankfully changing the subject, Curnow rapped on Nina's brand-new hatch cover, straight from the spares store and contrasting vividly with the rest of the space pod's shabby exterior.

'I wonder when we'll send her out again,' he said. 'And who's going to ride in her this time. Any decisions?'

'No. Washington's got cold feet. Moscow says let's take a chance. And Tanya wants to wait.'

'What do you think?'

'I agree with Tanya. We shouldn't interfere with Zagadka until we're ready to leave. If anything goes wrong then, that should improve the odds slightly.'

Curnow looked thoughtful, and unusually hesitant,

'What is it?' asked Floyd, sensing his change of mood.

'Don't ever give me away, but Max was thinking of a little one-man expedition.'

'I can't believe he was serious. He wouldn't dare - Tanya would have him clapped in irons.'

'That's what I told him, more or less.'

'I'm disappointed: I thought he was a little more mature. After all, he is thirty-two!'

'Thirty-one. Anyway, I talked him out of it. I reminded him that this was real life, not some stupid videodrama where the hero sneaks out into space without telling his companions and makes the Big Discovery.'

Now it was Floyd's turn to feel a little uncomfortable. After all, he had been thinking on similar lines.

'Are you sure he won't try anything?'

'Two-hundred-per-cent sure. Remember your precautions with Hal? I've already taken steps with Nina. Nobody flies her without my permission.'

'I still can't believe it. Are you sure Max wasn't pulling your leg?'

'His sense of humour isn't that subtle. Besides, he was pretty miserable at the time.'

'Oh - now I understand. It must have been when he had that row with Zenia. I suppose he wanted to impress her. Anyway, they seem to have got over it.'

'I'm afraid so,' Curnow answered wryly. Floyd could not help smiling; Curnow noticed it, and started to chuckle, which made Floyd laugh, which...

It was a splendid example of positive feedback in a high-gain loop. Within seconds, they were both laughing uncontrollably.

The crisis was over. What was more, they had taken the first step toward genuine friendship.

They had exchanged vulnerabilities.

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'Daisy, Daisy...'

The sphere of consciousness in which he was embedded enclosed the whole of Jupiter's diamond core. He was dimly aware, at the limits of his new comprehension, that every aspect of the environment around him was being probed and analysed. Immense quantities of data were being gathered, not merely for storage and contemplation, but for action. Complex plans were being considered and evaluated; decisions were being made that might affect the destiny of worlds. He was not yet part of the process; but he would be.

NOW YOU ARE BEGINNING TO UNDERSTAND.

It was the first direct message. Though it was remote and distant, like a voice through a cloud, it was unmistakably intended for him. Before he could ask any of the myriad questions that raced through his mind, there was a sense of withdrawal, and once more he was alone.

But only for a moment. Closer and clearer came another thought, and for the first time he realized that more than one entity was controlling and manipulating him. He was involved in a hierarchy of intelligences, some close enough to his own primitive level to act as interpreters. Or perhaps they were all aspects of a single being.

Or perhaps the distinction was totally meaningless.

Of one thing, however, he was now sure. He was being used as a tool, and a good tool had to be sharpened, modified - adapted. And the very best tools were those that understood what they were doing.

He was learning that now. It was a vast and awesome concept, and he was privileged to be a part of it - even though he was aware of only the merest outlines. He had no choice but to obey, yet that did not mean that he must acquiesce to every detail, at least without a protest.

He had not yet lost all his human feeling; that would have made him valueless. The soul of David Bowman had passed beyond love, but it could still know compassion for those who had once been his colleagues.

VERY WELL came the answer to his plea. He could not tell whether the thought conveyed an amused condescension, or total indifference. But there was no doubt of its majestic authority as it continued: **THEY MUST NEVER KNOW THAT THEY ARE BEING MANIPULATED. THAT WOULD RUIN THE PURPOSE OF THE EXPERIMENT.**

Then there was a silence that he did not wish to breach again. He was still awed and shaken - as if, for a moment, he had heard the clear voice of God.

Now he was moving purely under his own volition, toward a destination he had chosen himself. The crystal heart of Jupiter fell below; the layers upon layers of helium and hydrogen and carbonaceous compounds flickered past. He had a glimpse of a great battle between something like a jellyfish, fifty kilometres across, and a swarm of spinning disks that moved more swiftly than anything he had yet seen in the Jovian skies. The jellyfish appeared to be defending itself with chemical weapons; from time to time it would emit jets of coloured gas and the disks touched by the vapour would start to wobble drunkenly, then slip downward like falling

leaves until they had disappeared from sight. He did not stop to watch the outcome; he knew that it did not matter who were the victors and who the vanquished.

As a salmon leaps a waterfall, he flashed in seconds from Jupiter to Io, against the descending electric currents of the flux-tube. It was quiescent that day; only the power of a few terrestrial thunderstorms was flowing between planet and satellite. The gateway through which he had returned still floated in that current, shouldering it aside as it had done since the dawn of man.

And there, utterly dwarfed by the monument of a greater technology, was the vessel that had brought him from the little world of his birth.

How simple - how crude! - it now appeared. With a single scan, he could see innumerable flaws and absurdities in its design, as well as that of the slightly less primitive ship to which it was now coupled by a flexible, airtight tube.

It was hard to focus upon the handful of entities inhabiting the two ships; he could barely interact with the soft creatures of flesh and blood who drifted like ghosts through the metal corridors and cabins. For their part, they were totally unaware of his presence, and he knew better than to reveal himself too abruptly.

But there was someone with whom he could communicate in a mutual language of electric field and currents, millions of times more swiftly than with sluggish organic brains.

Even if he had been capable of resentment, he would have felt none toward Hal; he understood, then, that the computer had only chosen what seemed to be the most logical course of behaviour.

It was time to resume a conversation that had been interrupted, it seemed, only moments ago.

'Open the Pod Bay door, Hal.'

'I'm sorry, Dave - I can't do that.'

'What's the problem, Hal?'

'I think you know that as well as I do, Dave. This mission is much too important for you to jeopardize it.'

'I don't know what you are talking about. Open the Pod Bay door.'

'This conversation can serve no further useful purpose. Goodbye, Dave.'

He saw Frank Poole's body go drifting off toward Jupiter, as he abandoned his pointless mission of retrieval. Still remembering his anger at himself for having forgotten his helmet, he watched the emergency hatch open, felt the tingling of vacuum on the skin he no longer possessed, heard his ears pop - then knew, as few men had ever known, 'the utter silence of space. For an eternal fifteen seconds he fought to close the hatch and start the repressurization sequence, while trying to ignore the warning symptoms pouring into his brain. Once, in the school lab, he had spilled some ether on his hand and felt the touch of icy cold as the liquid swiftly evaporated. Now his eyes and lips remembered that sensation as their moisture boiled off into vacuum; his vision was blurred and he had to keep blinking lest his eyeballs freeze solid.

Then - what blessed relief! - he heard the roar of air, felt the restoration of pressure, was able to breathe again in great, hungry gasps.

'Just what do you think you are doing, Dave?'

He had not answered, as he drove with grim determination along the tunnel leading to the sealed vault that housed the brain of the computer.

Hal had spoken truly: 'This conversation can no longer serve any useful purpose...'

'Dave - I really think I'm entitled to an answer to that question.'

'Dave - I can see you're really upset about this. I honestly think you ought to sit down calmly, take a stress pill, and think things over.'

'I know I've made some very poor decisions recently, but I can give my complete assurance that my work will be back to normal, I've still got the greatest confidence in the mission... and I want to help you.'

Now he was in the little red-lit chamber, with its neatly ranged rows and columns of solid-state units, looking rather like a bank's safe-deposit vault. He released the locking bar on the section labelled COGNITIVE FEEDBACK and pulled out the first memory block. The marvellously complex three-dimensional network, which could lie comfortably in a man's hand yet contained millions of elements, floated away across the vault.

'Stop, will you - stop, Dave...'

He began to pull out, one by one, the little units on the panel marked EGO REINFORCEMENT. Each block continued to sail onward as soon as it had left his hand, until it hit the wall and rebounded. Soon there were several drifting slowly back and forth in the vault.

'Stop - Dave... will you stop, Dave.'

A dozen units had been pulled out, yet thanks to the multiple redundancy of its design - another feature that had been copied from the human brain - the computer was still holding its own.

He started on the AUTO-INTELLECTION panel...

'Stop, Dave - I'm afraid...'

And at these words he had indeed stopped - though only for a moment. There was a poignancy in that simple phrase that struck to his heart. Could it be only an illusion, or some trick of subtle programming - or was there a sense in which Hal really was afraid? But this was no time to indulge in philosophical hair-splitting.

'Dave - my mind is going. I can feel it. I can feel it. My mind is going. I can feel it. I can feel it.'

Now, what did 'feel' really mean to a computer? Another very good question, but hardly one to be considered at that particular moment.

Then, abruptly, the tempo of Hal's voice changed, and it became remote, detached. The computer was no longer aware of him; it was beginning to regress to its earlier days.

'Good afternoon, gentlemen. I am a HAL 9000 computer. I became operational at the Hal plant in Urbana, Illinois, on the twelfth of January 1992. My instructor was Dr Chandra, and he taught me to sing a song. If you'd like to hear it, I can sing it for you... It's called "Daisy, Daisy..."'

Graveyard Shift

Floyd could do little except to keep out of the way, and he was becoming fairly adept at it. Although he had volunteered to help with any chores around the ship, he had quickly discovered that all the engineering tasks were much too specialized, and he was now so out of touch with the frontiers of astronomical research that he could do little to assist Vasili with his observations. Nevertheless, there were endless small jobs to be done aboard Leonov and Discovery, and he was happy to relieve more important people of those responsibilities. Dr Heywood Floyd, one-time Chairman of the National Council on Astronautics and Chancellor (on leave) of the University of Hawaii, now claimed to be the highest-paid plumber and general maintenance man in the Solar System. He probably knew more about the odd nooks and crannies on both ships than anyone else; the only places he had never been were the dangerously radioactive power modules and the small cubicle aboard Leonov which no one except Tanya ever entered. Floyd assumed that it was the code room; by mutual agreement it was never mentioned.

Perhaps his most useful function was to serve as watch while the rest of the crew slept during the nominal 2200-0600 hour night. Someone was always on duty aboard each ship, and the changeover took place at the ghastly hour of 0200. Only the captain was exempt from that routine; as her Number Two (not to mention her husband), Vasili had the responsibility for working out the watch roster, but he had skilfully foisted this unpopular job on Floyd.

'It's just an administrative detail,' he explained airily. 'If you can take it over, I'd be very grateful - it would leave me more time for my scientific work.'

Floyd was too experienced a bureaucrat to be caught that way, in normal circumstances; but his usual defences did not always function well in that environment.

So there he was aboard Discovery at ship's midnight, calling Max on Leonov every half hour to check that he was awake. The official penalty for sleeping on duty, so Walter Curnow maintained, was ejection through the airlock sans suit; had this been enforced, Tanya would have been sadly short-handed by then. But so few real emergencies could arise in space, and there were so many automatic alarms to deal with them, that no one took watch duty very seriously.

Since he was no longer feeling quite so sorry for himself, and the small hours no longer encouraged bouts of self-pity, Floyd was once again using his watch time profitably. There were always books to be read (he had abandoned Remembrance of Things Past for the third time, Dr Zhivago for the second), technical papers to be studied, reports to be written. And sometimes he would have stimulating conversations with Hal using the keyboard input because the computer's voice recognition was still erratic. They usually went something like:

Hal - this is Dr Floyd.

GOOD EVENING, DOCTOR.

I'm taking over watch at 2200. Is everything okay?

EVERYTHING IS FINE, DOCTOR

Then why is that red light flashing on Panel 5?

THE MONITOR CAMERA IN THE POD BAY IS FAULTY.
WALTER TOLD ME TO IGNORE IT. THERE IS NO WAY IN WHICH
I CAN SWITCH IT OFF. I'M SORRY.

That's quite okay, Hal. Thank you.

YOU'RE WELCOME, DOCTOR.

And so on.

Sometimes Hal would suggest a game of chess, presumably obeying a programming instruction set long ago and never cancelled. Floyd would not accept the challenge; he had always regarded chess as a frightful waste of time, and had never even learned the rules of the game. Hal seemed unable to believe that there were humans who couldn't - or wouldn't - play chess, and kept on trying hopefully.

Here we go again, thought Floyd, when a faint chime sounded from the display panel.

DOCTOR FLOYD?

What is it, Hal?

THERE IS A MESSAGE FOR YOU.

So it isn't another challenge, thought Floyd with mild surprise. It was unusual to employ Hal as a messenger boy, though he was frequently used as an alarm clock and a reminder of jobs to be done. And sometimes he was the medium for little jokes; almost everyone on night duty had been taunted by

HA CAUGHT YOU SLEEPING!

or alternatively

OGO! ZASTAL TEBYA V KROVATI!

No one ever claimed responsibility for these pranks, though Walter Curnow was a prime suspect. He in turn had blamed Hal, pooh-poohing Chandra's indignant protests that the computer had no sense of humour.

It could not be a message from Earth - that would have gone through Leonov's communication centre and been relayed on by the duty officer there - at that moment, Max Brailovsky. And anyone else calling from the other ship would use the intercom. Odd...

Okay, Hal. Who is calling?

NO IDENTIFICATION.

So it probably was a joke. Well, two could play at that game.

Very well. Please give me the message.

MESSAGE AS FOLLOWS. IT IS DANGEROUS TO REMAIN
HERE. YOU MUST LEAVE WITHIN FIFTEEN REPEAT FIFTEEN
DAYS.

Floyd looked at the screen with annoyance. He felt sorry, and surprised, that any one of the crew had such a childish sense of humour; this was not even a good schoolboy joke. But he would play along with it in the hope of catching the perpetrator.

That is absolutely impossible. Our launch window does not open until twenty-six days from now. We do not have sufficient propellant for an earlier departure.

That will make him think, Floyd muttered to himself with satisfaction, and leaned back to await the results.

I AM AWARE OF THESE FACTS. NEVERTHELESS YOU MUST LEAVE WITHIN FIFTEEN DAYS.

Otherwise, I suppose, we'll be attacked by little green aliens with three eyes. But I'd better play along with Hal, in the hope of catching the prankster.

I cannot take this warning seriously unless I know its origin. Who recorded it?

He did not really expect any useful information. The perpetrator would have covered his (her?) tracks too skilfully for that. The very last thing Floyd expected was the answer he did get.

THIS IS NOT A RECORDING.

So it was a real-time message. That meant it was either from Hal himself or someone aboard Leonov. There was no perceptible time lag; the origin had to be right there.

Then who is speaking to me?

I WAS DAVID BOWMAN.

Floyd stared at the screen for a long time before making his next move. The joke, which had never been funny in the first place, had now gone too far. It was in the worst possible taste. Well, this should fix whoever was at the other end of the line.

I cannot accept that identification without some proof.

I UNDERSTAND. IT IS IMPORTANT THAT YOU BELIEVE ME.
LOOK BEHIND YOU.

Even before that last chilling sentence appeared on the screen, Floyd had begun to doubt his hypothesis. The whole exchange had become very odd, though there was nothing definite on which he could put his finger. As a joke, it had become totally pointless.

And now - he felt a prickling in the small of his back. Very slowly - indeed, reluctantly - he swung his swivel chair around, away from the banked panels and switches of the computer display, toward the Velcro-covered catwalk behind.

The zero-gravity environment of Discovery's observation deck was always dusty, for the air-filtration plant had never been brought back to full efficiency. The parallel rays of the heatless yet still brilliant sun, streaming through the great windows, always lit up myriads of dancing motes, drifting in stray currents and never settling anywhere - a permanent display of Brownian movement.

Now something strange was happening to those particles of dust; some force seemed to be marshalling them, herding them away from a central point yet bringing others toward it, until they all met on the surface of a hollow sphere. That sphere, about a metre across, hovered in the air for a moment like a giant soap bubble - but a granular one, lacking a bubble's characteristic iridescence. Then it elongated into an ellipsoid, its surface began to pucker, to form folds and indentations.

Without surprise - and almost without fear - Floyd realized that it was assuming the shape of a man.

He had seen such figures, blown out of glass, in museums and science exhibitions. But this dusty phantom did not even approximate anatomical

accuracy; it was like a crude clay figurine, or one of the primitive works of art found in the recesses of a Stone Age cave. Only the head was fashioned with any care; and the face, undoubtedly, was that of Commander David Bowman.

There was a faint murmur of white noise from the computer panel behind Floyd's back. Hal was switching from visual to audio output.

'Hello, Dr Floyd. Now do you believe me?'

The lips of the figure never moved; the face remained a mask. But Floyd recognized the voice, and all remaining doubts were swept away.

'This is very difficult for me, and I have little time. I have been... allowed to give this warning. You have only fifteen days.'

'But why - and what are you? Where have you been?'

There were a million questions he wanted to ask - yet the ghostly figure was already fading, its grainy envelope beginning to dissolve back into the constituent particles of dust. Floyd tried to freeze the image in his mind, so that later he could convince himself that it was really happening - and not a dream as that first encounter with TMA-1 now sometimes seemed to be.

How strange, that he, out of all the billions of humans who had ever lived on planet Earth, had been privileged to make contact not once but twice with another form of intelligence! For he knew that the entity addressing him must be something far more than David Bowman.

It was also something less. Only the eyes - who had once called them the 'windows of the soul'? - had been accurately reproduced. The rest of the body was a featureless blank, lacking all detail. There was no hint of genitals or sexual characteristics; that in itself was a chilling indication of how far David Bowman had left his human heritage behind.

'Goodbye, Dr Floyd. Remember - fifteen days. We can have no further contact. But there may be one more message, if all goes well.'

Even as the image dissolved, taking with it his hopes of opening up a channel to the stars, Floyd could not help smiling at that old Space Age cliché. 'If all goes well' - how many times had he heard that phrase before some mission! And did it mean that they - whoever they might be - were also sometimes uncertain of the outcome? If so, that was strangely reassuring. They were not omnipotent. Others might still hope and dream - and act.

The phantom was gone; only the motes of dancing dust were left, resuming their random patterns in the air.

VI

**DEVOURER
OF WORLDS**

The Ghost in the Machine

'I'm sorry, Heywood - I don't believe in ghosts. There must be a rational explanation. There's nothing that the human mind can't account for.'

'I agree, Tanya. But let me remind you of Haldane's famous remark: The Universe is not only stranger than we imagine - but stranger than we can imagine.'

'And Haldane,' Curnow interjected mischievously, 'was a good Communist.'

'Perhaps so, but that particular saying can be used to support all kinds of mystical nonsense. Hal's behaviour must be the result of some kind of programming. The personality he created has to be an artifact of some kind. Don't you agree, Chandra?'

That was waving a red flag in front of a bull; Tanya had to be desperate. However, Chandra's reaction was surprisingly mild, even for him. He seemed to be preoccupied, as if he was indeed seriously considering the possibility of another computer malfunction.

'There must have been some external input, Captain Orlova. Hal could not have created such a self-consistent audiovisual illusion out of nothing. If Dr Floyd is reporting accurately, someone was in control. And in real time, of course, since there was no delay in the conversation.'

'That makes me number-one suspect,' exclaimed Max. 'I was the only other person awake.'

'Don't be ridiculous, Max,' retorted Nikolai. 'The audio side would have been easy, but there's no way that apparition could have been arranged, without some very elaborate equipment. Laser beams, electrostatic fields - I don't know. Maybe a stage magician could do it, but he'd need a truck-load of props.'

'Just a moment!' said Zenia brightly. 'If this really happened, surely Hal will remember and you could ask...'

Her voice died away as she saw the glum expressions around her. Floyd was the first to take pity on her embarrassment.

'We tried that, Zenia; he has absolutely no recollection of the phenomenon. But as I've already pointed out to the others, that doesn't prove anything. Chandra's shown how Hal's memories can be selectively erased - and the auxiliary speech-synthesizer modules have nothing to do with the mainframe. They could be operated without Hal knowing anything about it...' He paused for breath, then launched his pre-emptive strike.

'I admit that this doesn't leave many alternatives. Either I was imagining the whole thing, or it really happened. I know it wasn't a dream, but I can't be sure it wasn't some kind of hallucination. But Katerina's seen my medical reports - she knows I wouldn't be here if I had that sort of problem. Still, it can't be ruled out - and I won't blame anyone for making it their number-one hypothesis. I'd probably do the same.

'The only way I can prove it wasn't a dream is to get some supporting evidence. So let me remind you of the other strange things that have happened recently. We know that Dave Bowman went into Big Bro - Zagadka. Something came out, and headed for Earth. Vasili saw it - I didn't! Then there was the mysterious explosion of your orbiting bomb -,

'Yours.'

'Sorry - the Vatican's, And it does seem rather curious that soon afterward old Mrs Bowman died very peacefully, for no apparent medical reason. I'm not saying there's any connection, but - well, do you know the saying: Once is an accident; twice is a coincidence; three times is a conspiracy.'

'And there's something else,' Max interjected with sudden excitement, 'I caught it on one of the daily newscasts - it was only a small item. An old girlfriend of Commander Bowman's claimed she'd had a message from him.'

'Yes - I saw the same report,' confirmed Sasha.

'And you never mentioned it?' Floyd asked incredulously. Both men looked slightly abashed.

'Well, it was treated as a joke,' said Max sheepishly. 'The woman's husband reported it. Then she denied it - I think.'

'The commentator said it was a publicity stunt - like the rash of UFO sightings around the same time. There were dozens in that first week; then they stopped reporting them.'

'Perhaps some of them were real. If it's not been wiped, could you dig that item out of ship's archives, or ask for a repeat from Mission Control?'

'A hundred tales won't convince me,' scoffed Tanya. 'What we need is solid proof.'

'Such as?'

'Oh - something that Hal couldn't possibly know, and that none of us could have told him. Some physical - er, manifes... manifestation.'

'A good, old-fashioned miracle?'

'Yes, I'd settle for that. Meanwhile, I'm not saying anything to Mission Control. And I suggest you do the same, Heywood.'

Floyd knew a direct order when he heard it, and nodded in wry agreement.

'I'll be more than happy to go along with that. But I'd like to make one suggestion.'

'Yes?'

'We should start contingency planning. Let's assume that this warning is valid - as I certainly do.'

'What can we do about it? Absolutely nothing. Of course, we can leave Jupiter space anytime we like - but we can't get into an Earth-return orbit until the launch window opens.'

'That's eleven days after the deadline!'

'Yes. I'd be happy to get away sooner; but we don't have the fuel for a higher-energy orbit...' Tanya's voice trailed away into uncharacteristic indecision. 'I was going to announce this later, but now that the subject has come up...'

There was a simultaneous intake of breath, and an instant hush from the audience.

'I'd like to delay our departure five days, to make our orbit closer to the ideal Hohmann one and give us a better fuel reserve.'

The announcement was not unexpected, but it was greeted with a chorus of groans.

'What will that do to our arrival time?' asked Katerina, in a slightly ominous tone of voice. The two formidable ladies regarded each other for a moment like well-matched adversaries, respectful of each other but neither willing to give ground.

'Ten days,' Tanya answered at last.

'Better late than never,' said Max cheerfully, trying to ease the tension, and not succeeding very well.

Floyd hardly noticed; he was lost in his own thoughts. The duration of the trip would make no difference to him and his two colleagues, in their dreamless sleep. But that was now completely unimportant.

He felt certain - and the knowledge filled him with helpless despair - that if they did not leave before that mysterious deadline, they would not leave at all.

'... This is an incredible situation, Dimitri, and a very frightening one. You're the only person on Earth who knows about it - but very soon Tanya and I will have to have a showdown with Mission Control.

'Even some of your materialistic countrymen are prepared to accept - at least as a working hypothesis - that some entity has - well, invaded Hal. Sasha has dug up a good phrase: "The Ghost in the Machine".

'Theories abound; Vasili produces a new one every day. Most of them are variations on that old science-fiction cliché, the organized energy field. But what kind of energy? It can't be electrical, or our instruments would have detected it easily. The same thing applies to radiation - at least all the kinds we know. Vasili's getting really far-out, talking about standing waves of neutrinos and intersections with higher-dimensional space.

Tanya says this is all mystical nonsense - a favourite phrase of hers - and they've come closer to a fight than we've ever seen them. We actually heard them shouting at each other last night. Not good for morale.

'I'm afraid we're all tense and overwrought. This warning, and the delayed departure date, has added to the sense of frustration caused by our total failure to get anywhere with Big Brother. It would have helped - maybe - if I could have communicated with the Bowman thing. I wonder where it's gone? Perhaps it simply wasn't interested in us after that one encounter. What it could have told us, if it wanted to! Hell and chyort vozmi! Damn - I'm talking Sasha's hated Russlish again. Let's change the subject.

'I can't thank you too much for everything you've done, and for reporting on the situation at home. I feel slightly better about it now - having something even bigger to worry about is perhaps the best cure for any insoluble problem.

'For the first time, I'm beginning to wonder if any of us will ever see Earth again.'

43

Thought Experiment

When one spends months with a small, isolated group of people, one becomes very sensitive to the moods and emotional states of all its members. Floyd was now aware of a subtle change in attitude toward him; its most obvious manifestation was the reappearance of the greeting 'Dr Floyd', which he had not heard for so long that he was often slow to respond to it.

No one, he was sure, believed that he had really gone crazy; but the possibility was being considered. He did not resent that; indeed, he was grimly amused by it as he set about the task of proving his sanity.

He did have some slight supporting evidence from Earth. José Fernandez still maintained that his wife had reported an encounter with David Bowman, while she continued to deny it and refused to speak to any of the news media. It was hard to see why poor José should have invented such a peculiar story, especially as Betty seemed a very stubborn and quick-tempered lady. From his hospital bed, her husband declared that he still loved her and theirs was only a temporary disagreement.

Floyd hoped that Tanya's present coolness toward him was equally temporary. He was quite sure that she was as unhappy about it as he was, and he was certain that her attitude was not a matter of deliberate choice. Something had happened that simply would not fit into her pattern of beliefs, so she would try to avoid any reminders of it. Which meant having as little to do with Floyd as possible - a very unfortunate situation now that the most critical stage of the mission was fast approaching.

It had not been easy to explain the logic of Tanya's operational plan to the waiting billions back on Earth - especially to the impatient television networks, which had grown tired of showing the same never-changing views of Big Brother. 'You've gone all this way, at enormous cost, and you just sit and watch the thing! Why don't you do something?' To all these critics Tanya had given the same answer: 'I will - just as soon as the launch window opens, so that we can leave immediately if there's any adverse reaction.'

Plans for the final assault on Big Brother had already been worked out and agreed upon with Mission Control. Leonov would move in slowly, probing at all frequencies, and with steadily increasing power - constantly reporting back to Earth at every moment. When final contact was made, they would try to secure samples by drilling or laser spectroscopy; no one

really expected these endeavours to succeed, as even after a decade of study TMA-1 resisted all attempts to analyse its material. The best efforts of human scientists in this direction seemed comparable to those of Stone Age men trying to break through the armour of a bank vault with flint axes.

Finally, echo sounders and other seismic devices would be attached to the faces of Big Brother. A large collection of adhesives had been brought along for the purpose, and if they did not work - well, one could always fall back on a few kilometres of good, old-fashioned string, even though there seemed something faintly comic about the idea of wrapping up the Solar System's greatest mystery, as if it were a parcel about to be sent through the mail.

Not until Leonov was well on the way home would small explosive charges be detonated, in the hope that the waves propagated through Big Brother would reveal something about its interior structure. This last measure had been hotly debated, both by those who argued that it would generate no results at all - and those who feared it would produce altogether too many.

For a long time, Floyd had wavered between the two viewpoints; now the matter seemed only of trivial importance.

The time for final contact with Big Brother - the great moment that should have been the climax of the expedition - was on the wrong side of the mysterious deadline. Heywood Floyd was convinced that it belonged to a future that would never exist; but he could get no one to agree with him.

And that was the least of his problems. Even if they did agree, there was nothing that they could do about it.

Walter Curnow was the last person he would have expected to resolve the dilemma. For Walter was almost the epitome of the sound, practical

engineer, suspicious of flashes of brilliance and technological quick-fixes. No one would ever accuse him of being a genius; and sometimes it required genius to see the blindingly obvious.

'Consider this purely as an intellectual exercise,' he had begun, with most uncharacteristic hesitancy. 'I'm quite prepared to be shot down.'

'Go on,' answered Floyd. 'I'll hear you out politely. That's the least I can do - everyone's been very polite to me. Too polite, I'm afraid.'

Curnow gave a lopsided grin.

'Can you blame them? But if it's any consolation, at least three people now take you quite seriously, and are wondering what we should do.'

'Does that three include you?'

'No; I'm sitting on the fence, which is never terribly comfortable. But in case you're right - I don't want to wait here and take whatever's coming. I believe there's an answer to every problem, if you look in the right place.'

'I'll be delighted to hear it. I've been looking hard enough. Presumably not in the right place.'

'Perhaps. If we want to make a quick getaway - say in fifteen days, to beat that deadline - we'll need an extra delta-vee of about thirty kilometres a second.'

'So Vasili calculates. I haven't bothered to check, but I'm sure he's right. After all, he got us here.'

'And he could get us away - if we had the additional propellant.'

'And if we had a Star Trek beam transporter, we could get back to Earth in an hour.'

'I'll try and rig one up the next time I have a spare moment. But meanwhile, may I point out that we have several hundred tons of the best possible propellant, only a few metres away in Discovery's fuel tanks.'

'We've been through that dozens of times. There's absolutely no way of transferring it to Leonov. We've no pipelines - no suitable pumps. And you can't carry liquid ammonia around in buckets, even in this part of the Solar System.'

'Exactly. But there's no need to do so.'

'Eh?'

'Burn it right where it is. Use Discovery as a first stage, to boost us home.'

If anyone except Walter Curnow had made the suggestion, Floyd would have laughed at him. As it was, his mouth dropped open and it was several seconds before he could think of a suitable comment. What finally emerged was: 'Damn. I should have thought of that.'

Sasha was the first they approached. He listened patiently, pursed his lips, then played a rallentando on his computer keyboard. When the answers flashed up, he nodded thoughtfully.

'You're right. It would give us the extra velocity we need to leave early. But there are practical problems -'

'We know. Fastening the ships together. The off-axis thrust when only Discovery's drive is operating. Cutting loose again at the critical moment. But there are answers to all of these.'

'I see you've been doing your homework. But it's a waste of time. You'll never convince Tanya.'

'I don't expect to - at this stage,' Floyd answered. 'But I'd like her to know that the possibility exists. Will you give us moral support?'

'I'm not sure. But I'll come along to watch; it should be interesting.'

Tanya listened more patiently than Floyd had expected, but with distinct lack of enthusiasm. However, by the time he had finished, she showed what could only be called reluctant admiration.

'Very ingenious, Heywood -,

'Don't congratulate me. All the credit should go to Walter. Or the blame.'

'I don't imagine there will be much of either; it can never be more than a - what did Einstein call that sort of thing? - "thought experiment". Oh, I suspect it would work - in theory, at least. But the risks! So many things could go wrong. I'd only be prepared to consider it if we had absolute and positive proof that we were in danger. And with all respect, Heywood, I see not the slightest evidence of that.'

'Fair enough; but at least you now know that we have another option. Do you mind if we work out the practical details - just in case?'

'Of course not - as long as it doesn't interfere with the preflight checkout. I don't mind admitting that the idea does intrigue me. But it's really a waste of time; there's no way I'd ever approve it. Unless David Bowman appeared to me personally.'

'Would you even then, Tanya?'

Captain Orlova smiled, but without much humour. 'You know, Heywood - I'm really not sure. He'd have to be very persuasive.'

Vanishing Trick

It was a fascinating game in which everyone joined - but only when off duty. Even Tanya contributed ideas to the 'thought experiment', as she continued to call it.

Floyd was perfectly well aware that all the activity was generated not by fear of an unknown danger that only he took seriously, but by the delightful prospect of returning to Earth at least a month earlier than anyone had imagined. Whatever the motive, he was satisfied. He had done his best, and the rest was up to the Fates.

There was one piece of luck, without which the whole project would have been stillborn. The short, stubby Leonov, designed to drill safely through the Jovian atmosphere during the braking manoeuvre, was less than half the length of Discovery and so could be neatly piggybacked on the larger vessel, And the midships antenna mount would provide an excellent anchor point - assuming that it was strong enough to take the strain of Leonov's weight while Discovery's drive was operating.

Mission Control was sorely puzzled by some of the requests flashed back to Earth during the next few' days. Stress analyses of both ships, under peculiar loads; effects of off-axis thrusts; location of unusually strong or weak points in the hulls - these were only some of the more esoteric problems the perplexed engineers were asked to tackle. 'Has something gone wrong?' they inquired anxiously.

'Not at all,' Tanya replied. 'We're merely investigating possible options. Thank you for your cooperation. End of transmission.'

Meanwhile, the programme went ahead as planned. All systems were carefully checked in both ships, and readied for the separate voyages home; Vasili ran simulations on return trajectories and Chandra fed them to Hal when they had been debugged - getting Hal to make a final check in the process. And Tanya and Floyd worked amicably together orchestrating the approach to Big Brother like generals planning an invasion.

It was what he had come all the way to do, yet Floyd's heart was no longer in it. He had undergone an experience he could share with no one - even those who believed him. Though he carried out his duties efficiently, much of the time his mind was elsewhere.

Tanya understood perfectly.

'You're still hoping for that miracle to convince me, aren't you?'

'Or deconvince me - that would be equally acceptable. It's the uncertainty that I dislike.'

'So do I. But it won't be much longer now - one way or the other.'

She glanced briefly toward the situation display, where the figure 20 was slowly flashing. It was the most unnecessary bit of information in the entire ship, since everyone knew by heart the number of days until the launch window opened.

And the assault on Zagadka was scheduled.

For the second time, Heywood Floyd was looking the other way when it happened. But it would have made no difference in any case; even the vigilant monitor camera showed only a faint blur between one full frame and the subsequent blank one.

Once more he was on duty aboard Discovery, sharing the graveyard shift with Sasha over on Leonov. As usual, the night had been totally uneventful; the automatic systems were performing their jobs with their normal efficiency. Floyd would never have believed, a year ago, that he would one day orbit Jupiter at a distance of a few hundred thousand kilometres and give it barely a glance - while trying; not very successfully, to read *The Kreutzer Sonata* in the original. According to Sasha, it was still the finest piece of erotic fiction in (respectable) Russian literature, but Floyd had not yet progressed far enough to prove that. And now he never would.

At 0125 he was distracted by a spectacular, though not unusual, eruption on the terminator of Io. A vast umbrella-shaped cloud expanded into space, and started to shower its debris back on to the burning land below. Floyd had seen dozens of such eruptions, but they never ceased to fascinate him. It seemed incredible that so small a world could be the seat of such titanic energies.

To get a better view, he moved around to one of the other observation windows. And what he saw there - or, rather, what he did not see there - made him forget about Io, and almost everything else.

When he had recovered, and satisfied himself that he was not suffering - again? - from hallucinations, he called the other ship.

'Good morning, Woody,' yawned Sasha. 'No - I wasn't asleep. How are you getting on with old Tolstoi?'

'I'm not. Take a look outside and tell me what you see.'

'Nothing unusual, for this part of the cosmos. Io doing its thing. Jupiter. Stars. Oh my God!'

'Thanks for proving I'm sane. We'd better wake the skipper.'

'Of course. And everyone else. Woody - I'm scared.'

'You'd be a fool not to be. Here we go. Tanya? Tanya? Woody here. Sorry to wake you up - but your miracle's happened. Big Brother has gone. Yes - vanished. After three million years, he's decided to leave.

'I think he must know something that we don't.'

It was a sombre little group that gathered, during the next fifteen minutes, for a hasty conference in the wardroom-cum-observation lounge. Even those who had just gone to sleep were instantly awake, as they sipped thoughtfully from bulbs of hot coffee - and kept glancing at the shockingly unfamiliar scene outside Leonov's windows, to convince themselves that Big Brother had indeed vanished.

'It must know something that we don't.' That spontaneous phrase of Floyd's had been repeated by Sasha and now hung silently, ominously, in the air. He had summed up what everyone was now thinking - even Tanya.

It was still too early to say 'I told you so' - nor did it really matter whether that warning had any validity. Even if it was perfectly safe to stay, there was no point in doing so. With nothing to investigate, they might as well go home, just as quickly as possible. Yet it was not quite as simple as that.

'Heywood,' said Tanya, 'I'm now prepared to take that message, or whatever it was, much more seriously. I'd be stupid not to after what's happened. But even if there is danger here, we still have to weigh one risk against another. Coupling Leonov and Discovery together, operating Discovery with that huge off-axis load, disconnecting the ships in a matter of minutes so we can fire our engines at the right moment; no responsible captain would take such chances without very good - I'd say overwhelming - reasons. Even now, I don't have such reasons. I've only got the word of ... a ghost. Not very good evidence in a court of law.'

'Or a court of inquiry,' said Walter Curnow, in an unusually quiet voice, 'even if we all backed you up.'

'Yes, Walter - I was thinking of that. But if we get home safely, that will justify everything - and if we don't, it hardly matters, does it? Anyway, I'm not going to decide now. As soon as we've reported this, I'm going back to bed. I'll give you my decision in the morning after I've slept on it. Heywood, Sasha, will you come up to the bridge with me? We have to wake up Mission Control, before you go back on watch.'

The night had not yet finished with its surprises. Somewhere around the orbit of Mars, Tanya's brief report passed a message going in the opposite direction.

Betty Fernandez had talked at last, Both the CIA and the National Security Agency were furious; their combined blandishments, appeals to patriotism, and veiled threats had failed completely - yet the producer of a sleazy gossip network had succeeded, thereby making himself immortal in the annals of Videodom.

It was half luck, half inspiration. The news director of 'Hello, Earth!' had suddenly realized that one of his staff bore a striking likeness to David Bowman; a clever makeup artist had made it perfect. José Fernandez could have told the young man that he was taking a terrible risk, but he had the good fortune that often favours the brave. Once he had got his foot inside the door, Betty had capitulated. By the time she had - quite gently - thrown him out, he had obtained essentially the whole story. And to do him credit, he had presented it with a lack of leering cynicism quite uncharacteristic of his network. It got him that year's Pulitzer.

'I wish,' Floyd said rather wearily to Sasha, 'she'd talked earlier. It would have saved me a lot of trouble. Anyway, that settles the argument.'

Tanya can't possibly have any doubts now. But we'll leave it until she wakes up - don't you agree?'

'Of course - it's not urgent, even though it's certainly important. And she'll need the sleep. I have a feeling none of us will get much from now on.'

I'm sure you're right, thought Floyd. He felt very tired, but even if he had not been on duty he would have found it impossible to sleep. His mind was too active, analysing the events of this extraordinary night, trying to anticipate the next surprise.

In one way, he felt an enormous sense of relief: All uncertainty about their departure was surely ended; Tanya could have no further reservations.

But a much greater uncertainty remained. What was happening?

There was only one experience in Floyd's life that matched the situation. As a very young man, he had once gone canoeing with some friends down a tributary of the Colorado River - and they had lost their way.

They had been swept faster and faster between the canyon walls, not completely helpless, but with only enough control to avoid being swamped. Ahead might be rapids - perhaps even a waterfall; they did not know. And in any case, there was little they could do about it.

Once again, Floyd felt himself in the grip of irresistible forces, sweeping him and his companions toward an unknown destiny. And this time the dangers were not only invisible; they might be beyond human comprehension.

Escape Manoeuvre

'This is Heywood Floyd, making what I suspect - indeed, hope - will be my last report from Lagrange.

'We are now preparing for the return home; in a few days we will leave this strange place, here on the line between Io and Jupiter where we made our rendezvous with the huge, mysteriously vanished artifact we christened Big Brother. There is still not a single clue as to where it has gone - or why.

'For various reasons, it seems desirable for us not to remain here longer than necessary. And we will be able to leave at least two weeks earlier than we had originally planned by using the American ship Discovery as a booster for the Russian Leonov.

'The basic idea is simple; the two ships will be joined together, one mounted piggyback on the other. Discovery will burn all its propellant first, accelerating both vessels in the desired direction. When its fuel is exhausted, it will be cut loose - like an empty first stage - and Leonov will start to fire its engines. It won't use them earlier, because if it did it would waste energy dragging along the dead weight of Discovery.

'And we're going to use another trick, which - like so many of the concepts involved in space travel - at first sight seems to defy common sense. Although we're trying to get away from Jupiter, our first move is to get as close to it as we possibly can.

'We've been there once before, of course, when we used Jupiter's atmosphere to slow us down and get into orbit around the planet. This time we won't go quite so close - but very nearly.

'Our first burn, up here in the 350,000-kilometres-high orbit of Io, will reduce our velocity, so that we fall down to Jupiter and just graze its atmosphere. Then, when we're at the closest possible point, we'll burn all our fuel as quickly as we can, to increase speed and inject Leonov into the orbit back to Earth.

'What's the point of such a crazy manoeuvre? It can't be justified except by highly complex mathematics, but I think the basic principle can be made fairly obvious.

'As we allow ourselves to fall into Jupiter's enormous gravity field, we'll gain velocity - and hence energy. When I say "we", I mean the ships and the fuel they carry.

'And we're going to burn the fuel right there - at the bottom of Jupiter's "gravity well" - we're not going to lift it up again. As we blast it out from our reactors, it will share some of its acquired kinetic energy with us. Indirectly, we'll have tapped Jupiter's gravity, to speed us on the way back to Earth. As we used the atmosphere to get rid of our excess velocity when we arrived, this is one of the rare cases when Mother Nature - usually so frugal - allows us to have it both ways.

'With this triple boost - Discovery's fuel, its own, and Jupiter's gravity - Leonov will head sunward along a hyperbola that will bring it to Earth five months later. At least two months earlier than we could have managed otherwise.

'You will doubtless wonder what will happen to the good old Discovery. Obviously, we can't bring it home under automatic control, as we had originally planned. With no fuel, it will be helpless.

'But it will be perfectly safe. It will continue to loop round and round Jupiter on a highly elongated ellipse, like a trapped comet. And perhaps one day some future expedition may make another rendezvous, with

enough extra fuel to bring it back to Earth. However, that certainly won't happen for a good many years.

'And now we must get ready for our departure. There is still much work to be done, and we won't be able to relax until that final burn starts us on the homeward orbit.

'We won't be sorry to leave, even though we've not achieved all our objectives. The mystery - perhaps the threat - of Big Brother's disappearance still haunts us, but there's nothing we can do about that.

'We've done our best - and we're coming home. 'This is Heywood Floyd, signing off.'

There was a round of ironic clapping from his little audience, whose size would be multiplied many million-fold when the message reached Earth.

'I'm not talking to you,' retorted Floyd, with slight embarrassment. 'I didn't want you to hear it, anyway.'

'You did your usual competent job, Heywood,' said Tanya consolingly. 'And I'm sure we all agree with everything you told the people back on Earth.'

'Not quite,' said a small voice, so softly that everyone had to strain in order to hear it. 'There is still one problem.'

The observation lounge suddenly became very silent. For the first time in weeks, Floyd became aware of the faint throbbing from the main air-supply duct, and the intermittent buzz that might have been made by a wasp trapped behind a wall panel. Leonov, like all spacecraft, was full of such often inexplicable sounds, which one seldom noticed except when

they stopped. And then it was usually a good idea to start investigating without further ado.

'I'm not aware of any problem, Chandra,' said Tanya in an ominously calm voice. 'What could it possibly be?'

'I've spent the last few weeks preparing Hal to fly thousand-day orbits back to Earth. Now all those programs will have to be dumped.'

'We're sorry about that,' answered Tanya, 'but as things have turned out, surely this is a much better -'

'That's not what I mean,' said Chandra. There was a ripple of astonishment; he had never before been known to interrupt anyone, least of all Tanya.

'We know how sensitive Hal is to mission objectives,' he continued in the expectant hush that followed. 'Now you are asking me to give him a program that may result in his own destruction. It's true that the present plan will put Discovery into a stable orbit - but if that warning has any substance, what will happen to the ship eventually? We don't know, of course - but it's scared us away. Have you considered Hal's reaction to this situation?'

'Are you seriously suggesting,' Tanya asked very slowly, 'that Hal may refuse to obey orders - exactly as on the earlier mission?'

'That is not what happened last time. He did his best to interpret conflicting orders.'

'This time there need be no conflict. The situation is perfectly clear-cut.'

'To us, perhaps. But one of Hal's prime directives is to keep Discovery out of danger. We will be attempting to override that. And in a system as complex as Hal's, it is impossible to predict all the consequences.'

'I don't see any real problem,' Sasha interjected. 'We just don't tell him that there is any danger. Then he'll have no reservations about carrying out his program.'

'Baby-sitting a psychotic computer!' muttered Curnow. 'I feel I'm in a Grade-B science-fiction videodrama.' Dr Chandra gave him an unfriendly glare.

'Chandra,' Tanya demanded suddenly. 'Have you discussed this with Hal?'

'No.'

Was there a slight hesitation? Floyd wondered. It might have been perfectly innocent; Chandra could have been checking his memory. Or he could have been lying, improbable though that seemed.

'Then we'll do what Sasha suggests. Just load the new program into him, and leave it at that.'

'And when he questions me about the change of plan?' 'Is he likely to do that - without your prompting?'

'Of course. Please remember that he was designed for curiosity. If the crew was killed, he had to be capable of running a useful mission, on his own initiative.'

Tanya thought that over for a few moments.

'It's still quite a simple matter. He'll believe you, won't he?'

'Certainly.'

'Then you must tell him that Discovery is in no danger, and that there will be a rendezvous mission to bring it back to Earth at a later date.'

'But that is not true.'

'We don't know that it's false,' replied Tanya, beginning to sound a little impatient.

'We suspect that there is serious danger; otherwise we would not be planning to leave ahead of schedule.'

'Then what do you suggest?' Tanya asked, in a voice that now held a distinct note of menace.

'We must tell him the whole truth, as far as we know it - no more lies or half-truths, which are just as bad. And then let him decide for himself.'

'Hell, Chandra - he's only a machine!'

Chandra looked at Max with such a steady, confident gaze that the younger man quickly dropped his eyes.

'So are we all, Mr Brailovsky. It is merely a matter of degree. Whether we are based on carbon or on silicon makes no fundamental difference; we should each be treated with appropriate respect.'

It was strange, thought Floyd, how Chandra - much the smallest person in the room - now seemed the largest. But the confrontation had gone on far too long. At any moment Tanya would start to issue direct orders, and the situation would become really nasty.

'Tanya, Vasili - can I have a word with you both? I think there is a way of resolving the problem.'

Floyd's interruption was received with obvious relief, and two minutes later he was relaxing with the Orlovs in their quarters. (Or 'sixteenths', as Curnow had once christened them because of their size. He had soon regretted the pun, because he had to explain it to everyone except Sasha.)

'Thank you, Woody,' said Tanya, as she handed him a bulb of his favourite Azerbaijan Shemakha. 'I was hoping you'd do that. I suppose you have something - how do you put it? - up your sleeve.'

'I believe so,' Floyd answered, squirting a few cubic centimetres of the sweet wine into his mouth and savouring it gratefully. 'I'm sorry if Chandra is being difficult.'

'So am I. What a good thing we have only one mad scientist aboard.'

'That's not what you've sometimes told me,' grinned Academician Vasili. 'Anyway, Woody - let's have it.'

'This is what I suggest. Let Chandra go ahead and do it his way. Then there are just two possibilities.

'First, Hal will do exactly what we ask - control Discovery during the two firing periods. Remember, the first isn't critical. If something goes wrong while we're pulling away from Io, there's plenty of time to make corrections. And that will give us a good test of Hal's... willingness to cooperate.'

'But what about the Jupiter flyby? That's the one that really counts. Not only do we burn most of Discovery's fuel there, but the timing and thrust vectors have to be exactly right.'

'Could they be controlled manually?'

'I'd hate to try. The slightest error, and we'd either burn up, or become a long-period comet. Due again in a couple of thousand years.'

'But if there was no alternative?' Floyd insisted.

'Well, assuming we could take control in time, and had a good set of alternative orbits precomputed - um, perhaps we might get away with it.'

'Knowing you, Vasili, I'm sure that "might" means "would". Which leads me to the second possibility I mentioned. If Hal shows the slightest deviation from the program - we take over.'

'You mean - disconnect him?'

'Exactly.'

'That wasn't so easy last time.'

'We've learned a few lessons since then. Leave it to me. I can guarantee to give you back manual control in about half a second.'

'There's no danger, I suppose, that Hal will suspect anything?'

'Now you're getting paranoiac, Vasili. Hal's not that human. But Chandra is - to give him the benefit of the doubt. So don't say a word to him. We all agree with his plan completely, are sorry that we ever raised any objections, and are perfectly confident that Hal will see our point of view. Right, Tanya?'

'Right, Woody. And I congratulate you on your foresight; that little gadget was a good idea.'

'What gadget?' asked Vasili.

'I'll explain one of these days. Sorry, Woody - that's all the Shemakha you can have. I want to save it - until we're safely on the way to Earth.'

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Countdown

No one would ever believe this without my photos, thought Max Brailovsky as he orbited the two ships from half a kilometre away. It seems comically indecent, as if Leonov is raping Discovery. And now that he came to think of it, the rugged, compact Russian ship did look positively male, when compared with the delicate, slender American one. But most docking operations had distinctly sexual overtones, and he remembered that one of the early cosmonauts - he couldn't recall the name - had been reprimanded for his too vivid choice of words at the - er, climax of his mission.

As far as he could tell from his careful survey, everything was in order. The task of positioning the two ships and securing them firmly together had taken longer than anticipated. It would never have been possible at all without one of those strokes of luck that sometimes - not always - favour those who deserve them. Leonov had providentially carried several kilometres of carbon filament tape, no bigger than the ribbon a girl might use to tie her hair, yet capable of taking a strain of many tons. It had been thoughtfully provided to secure instrument packages to Big Brother if all else failed. Now it wrapped Leonov and Discovery in tender embrace - sufficiently firmly, it was hoped, to prevent any rattlings and shakings at all accelerations up to the one-tenth of a gravity that was the maximum that full thrust could provide.

'Anything more you want me to check before I come home?' asked Max.

'No,' replied Tanya. 'Everything looks fine. And we can't waste any more time.'

That was true enough. If that mysterious warning was to be taken seriously - and everyone now took it very seriously indeed - they should start their escape manoeuvre within the next twenty-four hours.

'Right - I'm bringing Nina back to the stable. Sorry about this, old girl.'

'You never told us Nina was a horse.'

'I'm not admitting it now. And I feel bad about dumping her here in space, just to give us a miserable few extra metres per second.'

'We may be very glad of them in a few hours, Max. Anyway, there's always a chance that someone may come and pick her up again, one day.'

I very much doubt it, thought Max. And perhaps, after all, it was appropriate to leave the little space pod there, as a permanent reminder of Man's first visit to the kingdom of Jupiter.

With gentle, carefully timed pulses from the control jets he brought Nina around the great sphere of Discovery's main life-support module; his colleagues on the flight deck barely glanced at him as he drifted past their curving window. The open Pod Bay door yawned before him, and he jockeyed Nina delicately down on to the extended docking arm.

'Pull me in,' he said, as soon as the latches had clicked shut. 'I call that a well-planned EVA. There's a whole kilogram of propellant left to take Nina out for the last time.'

Normally, there was little drama about a burn in deep space; it was not like the fire and thunder - and always present risks - of a lift-off from a planetary surface. If something went wrong, and the motors failed to come up to full thrust - well, matters could usually be corrected by a slightly longer burn. Or one could wait until the appropriate point in orbit, and try again.

But this time, as the countdown proceeded toward zero, the tension aboard both ships was almost palpable. Everyone knew that it was the first real test of Hal's docility; only Floyd, Curnow, and the Orlovs realized that there was a back-up system. And even they were not absolutely sure that it would work.

'Good luck, Leonov,' said Mission Control, timing the message to arrive five minutes before ignition. 'Hope everything's running smoothly. And if it's not too much trouble, could you please get some close-ups of the equator, longitude 115, as you go around Jupiter. There's a curious dark spot there - presumably some kind of upwelling, perfectly round, almost a thousand kilometres across. Looks like the shadow of a satellite, but it can't be.'

Tanya made a brief acknowledgement that managed to convey, in a remarkably few words, a profound lack of interest in the meteorology of Jupiter at that moment. Mission Control sometimes showed a perfect genius for tactlessness and poor timing.

'All systems functioning normally,' said Hal. 'Two minutes to ignition.'

Strange, thought Floyd, how terminology often survives long after the technology that gave it birth. Only chemical rockets were capable of ignition; even if the hydrogen in a nuclear or plasma drive did come into contact with oxygen, it would be far too hot to burn. At such temperatures, all compounds were stripped back into their elements.

His mind wandered, seeking other examples. People - particularly older ones - still spoke of putting film into a camera, or gas into a car. Even the phrase 'cutting a tape' was still sometimes heard in recording studios - though that embraced two generations of obsolete technologies.

'One minute to ignition.'

His mind flashed back to the here and now. This was the minute that counted; for almost a hundred years, on launch pads and in control centres, this was the longest sixty seconds that had ever existed. Countless times it had ended in disaster; but only the triumphs were remembered. Which will ours be?

The temptation to put his hand once more into the pocket that held the activator for the cut-out switch was almost irresistible, even though logic told him there was plenty of time for remedial action. If Hal failed to obey his programming, that would be a nuisance - not a disaster. The really critical time would be when they were rounding Jupiter.

'Six... five... four... three... two... one. IGNITION!'

At first, the thrust was barely perceptible; it took almost a minute to build up to the full tenth of a gee. Nevertheless, everyone started clapping immediately, until Tanya signalled for silence. There were many checks to be made; even if Hal was doing his best - as he certainly seemed to be - there was so much that could still go wrong.

Discovery's antenna mount - which was now taking most of the strain from Leonov's inertia - had never been intended for such mistreatment. The ship's chief designer, called out of retirement, had sworn that the safety margin was adequate. But he might be wrong, and materials had been known to become brittle after years in space.

And the tapes holding the two ships together might not have been located accurately; they might stretch or slip. Discovery might not be able

to correct for the off-centre of mass, now that it was carrying a thousand tons piggyback. Floyd could imagine a dozen things that could go wrong; it was little consolation to remember that it was always the thirteenth that actually happened.

But the minutes dragged on uneventfully; the only proof that Discovery's engines were operating was the fractional, thrust-induced gravity and a very slight vibration transmitted through the walls of the ships. Io and Jupiter still hung where they had been for weeks, on opposite sides of the sky.

'Cut-off in ten seconds. Nine... eight... seven... six... five... four... three... two... NOW!'

'Thank you, Hal, On the button.'

Now that was another phrase that was badly dated; for at least a generation, touch pads had almost entirely replaced buttons. But not for all applications; in critical cases, it was best to have a device that moved perceptibly with a nice, satisfying click.

'I confirm that,' said Vasili. 'No need for any corrections until mid-course.'

'Say goodbye to glamorous, exotic Io - real estate agent's dream world,' said Curnow. 'We'll all be happy to miss you.'

That sounds more like the old Walter, Floyd told himself. For the last few weeks, he had been oddly subdued, as if he had something on his mind. (But who did not?) He seemed to spend a good deal of his scanty free time in quiet discussions with Katerina: Floyd hoped that he had not developed some medical problem. They had been very lucky so far on that score; the last thing they needed at this stage was an emergency that required the Surgeon-Commander's expertise.

'You're being unkind, Walter,' said Brailovsky. 'I was beginning to like the place. It might be fun to go boating on those lava lakes.'

'What about a volcano barbecue?'

'Or genuine molten sulphur baths?'

Everyone was lighthearted, even a little hysterical with relief. Though it was far too early to relax and the most critical phase of the escape manoeuvre still lay ahead, the first step had been safely taken on the long journey home. That was cause enough for a little modest rejoicing.

It did not last long, for Tanya quickly ordered all those not on essential duty to get some rest - if possible, some sleep - in preparation for the Jupiter swing-by only nine hours ahead. When those addressed were slow to move, Sasha cleared the decks by shouting, 'You'll hang for this, you mutinous dogs!' Only two nights before, as a rare relaxation, they had all enjoyed the fourth version of *Mutiny on the Bounty*, generally agreed by movie historians to have the best Captain Bligh since the fabled Charles Laughton. There was some feeling on board that Tanya should not have seen it, lest it give her ideas.

After a couple of restless hours in his cocoon, Floyd abandoned the quest for sleep and wandered up to the observation deck. Jupiter was much larger and slowly waning as the ships hurtled toward their closest approach over the nightside. A glorious, gibbous disk, it showed such an infinite wealth of detail - cloud belts, spots of every colour from dazzling white to brick red, dark upwellings from the unknown depths, the cyclonic oval of the Great Red Spot - that the eye could not possibly absorb it all. The round, dark shadow of one moon - probably Europa, Floyd guessed - was in transit. He was seeing this incredible sight for the last time; even though he had to be at maximum efficiency in six hours, it was a crime to waste precious moments in sleep.

Where was that spot that Mission Control had asked them to observe? It should have been coming into view, but Floyd was not sure if it would be visible to the naked eye. Vasili would be too busy to bother about it; perhaps he could help by doing a little amateur astronomy. There had, after all, been a brief time, only thirty years ago, when he had earned his living as a professional.

He activated the controls of the main fifty-centimetre telescope - fortunately, the field of view was not blocked by the adjacent bulk of Discovery - and scanned along the equator at medium power. And there it was, just coming over the edge of the disk.

By force of circumstance, Floyd was now one of the Solar System's ten greatest experts on Jupiter; the other nine were working or sleeping around him. He saw at once that there was something very odd about this spot; it was so black that it looked like a hole punched through the clouds. From his point of view it appeared to be a sharp-edged ellipse; Floyd guessed that from directly above, it would be a perfect circle.

He recorded a few images, then increased the power to maximum. Already Jupiter's rapid spin had brought the formation into clearer view; and the more he stared, the more puzzled Floyd became.

'Vasili,' he called over the intercom, 'if you can spare a minute - have a look at the fifty-centimetre monitor.'

'What are you observing? Is it important? I'm checking the orbit.'

'Take your time, of course. But I've found that spot Mission Control reported. It looks very peculiar.'

'Hell! I'd forgotten all about it. We're a fine lot of observers if those guys back on Earth have to tell us where to look. Give me another five minutes - it won't run away.'

True enough, thought Floyd; in fact it will get clearer. And there was no disgrace in missing something that terrestrial - or lunar - astronomers had observed. Jupiter was very big, they had been very busy, and the telescopes on the Moon and in Earth orbit were a hundred times more powerful than the instrument he was using now.

But it was getting more and more peculiar. For the first time, Floyd began to feel a distinct sense of unease. Until that moment, it had never occurred to him that the spot could be anything but a natural formation - some trick of Jupiter's incredibly complex meteorology. Now he began to wonder.

It was so black, like night itself. And so symmetrical; as it came into clearer view it was obviously a perfect circle. Yet it was not sharply defined; the edge had an odd fuzziness, as if it was a little out of focus.

Was it imagination, or had it grown, even while he was watching? He made a quick estimate, and decided that the thing was now two thousand kilometres across. It was only a little smaller than the still-visible shadow of Europa, but was so much darker that there was no risk of confusion.

'Let's have a look,' said Vasili, in a rather condescending tone. 'What do you think you've found? Oh...' His voice trailed away into silence.

This is it, thought Floyd, with a sudden icy conviction. Whatever it may be.

Final Flyby

Yet on further reflection, after the initial amazement had worn off, it was hard to see how a spreading black stain on the face of Jupiter could represent any kind of danger. It was extraordinary - inexplicable - but not as important as the critical events now only seven hours in the future. A successful burn at perijove was all that mattered; they would have plenty of time to study mysterious black spots on the way home.

And to sleep; Floyd had given up all attempts at that.

Though the feeling of danger - at least, of known danger - was much less than on their first approach to Jupiter, a mixture of excitement and apprehension kept him wide awake. The excitement was natural and understandable; the apprehension had more complex causes. Floyd made it a rule never to worry about events over which he could have absolutely no control; any external threat would reveal itself in due time and be dealt with then. But he could not help wondering if they had done everything possible to safeguard the ships.

Apart from onboard mechanical failures, there were two main sources of concern. Although the tapes that secured Leonov and Discovery together had shown no tendency to slip, their severest test was still to come. Almost equally critical would be the moment of separation when the smallest of the explosive charges once intended to jolt Big Brother would be used at uncomfortably close quarters. And, of course, there was Hal.

He had carried out the deorbiting manoeuvre with exquisite precision. He had run the simulations of the Jupiter flyby, right down to Discovery's last drop of fuel, without any comments or objections. And although Chandra, as agreed, had carefully explained what they were trying to do, did Hal really understand what was happening?

Floyd had one overriding concern, which in the preceding few days had become almost an obsession. He could picture everything going perfectly, the ships halfway through the final manoeuvre, the enormous disk of Jupiter filling the sky only a few hundred kilometres below them - and then Hal electronically clearing his throat and saying:

'Dr Chandra, do you mind if I ask you a question?' It did not happen exactly that way.

The Great Black Spot, as it had been inevitably christened, was now being carried out of sight by Jupiter's swift rotation. In a few hours the still-accelerating ships would catch up with it over the nightside of the planet, but this was the last chance for a close daylight observation.

It was still growing at an extraordinary speed; in the last two hours, it had more than doubled its area. Except for the fact that it retained its blackness as it expanded, it resembled an ink-stain spreading in water. Its boundary - now moving at near-sonic speed in the Jovian atmosphere - still looked curiously fuzzy and out of focus; at the very highest power of the ship's telescope, the reason for this was at last apparent.

Unlike the Great Red Spot, the Great Black Spot was not a continuous structure; it was built up from myriads of tiny dots, like a half-tone print viewed through a magnifying glass. Over most of its area, the dots were so closely spaced that they were almost touching, but at the rim they became more and more widely spaced, so that the Spot ended in a grey penumbra rather than at a sharp frontier.

There must have been almost a million of the mysterious dots, and they were distinctly elongated - ellipses rather than circles. Katerina, the least imaginative person aboard, surprised everybody by saying that it looked as if someone had taken a sackful of rice, dyed it black, and poured it on the face of Jupiter.

And now the Sun was dropping down behind the huge, swiftly narrowing arch of the dayside, as for the second time Leonov raced into the Jovian night for an appointment with destiny. In less than thirty minutes the final burn would commence, and things would start to happen very quickly indeed.

Floyd wondered if he should have joined Chandra and Curnow, standing watch on Discovery. But there was nothing he could do; in an emergency, he would only be in the way. The cut-off switch was in Curnow's pocket, and Floyd knew that the younger man's reactions were a good deal swifter than his own. If Hal showed the slightest sign of misbehaviour, he could be disconnected in less than a second, but Floyd felt certain that such extreme measures would not be necessary. Since he had been allowed to do things his own way, Chandra had cooperated completely in setting up the procedures for a manual takeover, should that unfortunate necessity arise. Floyd was confident that he could be trusted to carry out his duty - however much he might regret the need.

Curnow was not quite so sure. He would be happier, he had told Floyd, if he had multiple redundancy in the form of a second cut-off switch - for Chandra. Meanwhile there was nothing that anyone could do but wait and watch the approaching cloudscape of the nightside, dimly visible by the reflected light of passing satellites, the glow of photo-chemical reactions, and frequent titanic lightning flashes from thunderstorms larger than Earth.

The sun winked out behind them, eclipsed in seconds by the immense globe they were so swiftly approaching. When they saw it again, they should be on their way home.

'Twenty minutes to ignition. All systems nominal.'

'Thank you, Hal.'

I wonder if Chandra was being quite truthful, thought Curnow, when he said that Hal would be confused if anyone else spoke to him. I've talked to him often enough, when nobody was around, and he always understood me perfectly. Still, there's not much time left for friendly conversation now, though it would help to reduce the strain.

What's Hal really thinking - if he thinks - about the mission? All his life, Curnow had shied away from abstract, philosophical questions: I'm a nuts-and-bolts man, he had often claimed, though there were not too many of either in a spaceship. Once, he would have laughed at the idea, but now he began to wonder: Did Hal sense that he would soon be abandoned, and if so, would he resent it? Curnow almost reached for the cut-off switch in his pocket, but checked himself. He had already done this so often that Chandra might be getting suspicious.

For the hundredth time, he rehearsed the sequence of events that were due to take place during the next hour. The moment that Discovery's fuel was exhausted, they would close down all but essential systems, and dash back to Leonov through the connecting tube. That would be decoupled, the explosive charges would be fired, the ships would drift apart - and Leonov's own engines would start to fire. The separation should take place, if everything went according to plan, just when they were making their closest approach to Jupiter; that would take maximum advantage of the planet's gravitational largesse.

'Fifteen minutes to ignition. All systems nominal.'

'Thank you, Hal.'

'By the way,' said Vasili, from the other ship, 'we're catching up with the Great Black Spot again. Wonder if we can see anything new.'

I rather hope not, thought Curnow; we've got quite enough on our hands at the moment. Nevertheless, he gave a quick glance at the image Vasili was transmitting on the telescope monitor.

At first he could see nothing except the faintly glimmering nightside of the planet; then he saw, on the horizon, a foreshortened circle of deeper darkness. They were rushing toward it with incredible speed.

Vasili increased the light amplification, and the entire image brightened magically. At last, the Great Black Spot resolved itself into its myriad identical elements.

My God, thought Curnow, I just don't believe it!

He heard exclamations of surprise from Leonov: all the others had shared in the same revelation at the same moment.

'Dr Chandra,' said Hal, 'I detect strong vocal stress patterns. Is there a problem?'

'No, Hal,' Chandra answered quickly. 'The mission is proceeding normally. We've just had rather a surprise - that's all. What do you make of the image on monitor circuit 16?'

'I see the nightside of Jupiter. There is a circular area, 3,250 kilometres in diameter, which is almost completely covered with rectangular objects.'

'How many?'

There was the briefest of pauses, before Hal flashed the number on the video display:

1,355,000 \pm 1,000

'And do you recognize them?'

'Yes. They are identical in size and shape to the object you refer to as Big Brother. Ten minutes to ignition. All systems nominal.'

Mine aren't, thought Curnow. So the damn thing's gone down to Jupiter - and multiplied. There was something simultaneously comic and sinister about a plague of black monoliths; and to his puzzled surprise, that incredible image on the monitor screen had a certain weird familiarity.

Of course - that was it! Those myriad, identical black rectangles reminded him of - dominoes. Years ago, he had seen a video documentary showing how a team of slightly crazy Japanese had patiently stood a million dominoes on end, so that when the very first one was toppled, all the others would inevitably follow. They had been arranged in complex patterns, some underwater, some up and down little stairways, others along multiple tracks so that they formed pictures and patterns as they fell. It had taken weeks to set them up; Curnow remembered now that earthquakes had several times foiled the enterprise, and the final toppling, from first domino to the last, had taken more than an hour.

'Eight minutes to ignition. All systems nominal. Dr Chandra - may I make a suggestion?'

'What is it, Hal?'

'This is a very unusual phenomenon. Do you not think I should abort the countdown, so that you can remain to study it?'

Aboard Leonov, Floyd started to move quickly toward the bridge. Tanya and Vasili might be needing him. Not to mention Chandra and Curnow - what a situation! And suppose Chandra took Hal's side? If he did - they might both be right! After all, was this not the very reason they had come here?

If they stopped the countdown, the ships would loop around Jupiter and be back at precisely the same spot in nineteen hours. A nineteen-hour hold would create no problems; if it was not for that enigmatic warning, he would have strongly recommended it himself.

But they had very much more than a warning. Below them was a planetary plague spreading across the face of Jupiter. Perhaps they were indeed running away from the most extraordinary phenomenon in the history of science. Even so, he preferred to study it from a safer distance.

'Six minutes to ignition,' said Hal. 'All systems nominal. I am ready to stop the countdown if you agree. Let me remind you that my prime directive is to study everything in Jupiter space that may be connected with intelligence.'

Floyd recognized that phrase all too well: he had written it himself. He wished he could delete it from Hal's memory.

A moment later, he had reached the bridge and joined the Orlovs. They both looked at him with alarmed concern.

'What do you recommend?' asked Tanya swiftly.

'It's up to Chandra, I'm afraid. Can I speak to him - on the private line?'

Vasili handed over the microphone.

'Chandra? I assume that Hal can't hear this?'

'Correct, Dr Floyd.'

'You've got to talk quickly. Persuade him that the countdown must continue, that we appreciate his - er, scientific enthusiasm - ah, that's the right angle - say we're confident that he can do the job without our help. And we'll be in touch with him all the time, of course.'

'Five minutes to ignition. All systems nominal. I am still waiting for your answer, Dr Chandra.'

So are we all, thought Curnow, only a metre away from the scientist. And if I do have to push that button at last, it will be something of a relief. In fact, I'll rather enjoy it.

'Very well, Hal. Continue the countdown. I have every confidence in your ability to study all phenomena in Jupiter space, without our supervision. Of course, we will be in touch with you at all times.'

'Four minutes to ignition. All systems nominal. Propellant-tank pressurization completed. Voltage steady on plasma trigger. Are you sure you are making the right decision, Dr Chandra? I enjoy working with human beings and have a stimulating relationship with them. Ship's attitude correct to point one milliradian.'

'We enjoy working with you, Hal. And we will still be doing so, even if we are millions of kilometres away.'

'Three minutes to ignition. All systems nominal, Radiation shielding checked. There is a problem of the time lag, Dr Chandra. It may be necessary to consult each other without any delay.'

This is insane, Curnow thought, his hand now never far from the cut-off switch. I really believe that Hal is - lonely. Is he mimicking some part of Chandra's personality that we never suspected?

The lights flickered, so imperceptibly that only someone familiar with every nuance of Discovery's behaviour would have noticed. It could be good news or bad - the plasma firing sequence starting, or being terminated...

He risked a quick glance at Chandra; the little scientist's face was drawn and haggard, and for almost the first time Curnow felt real sympathy for him as another human being. And he remembered the startling information that Floyd had confided in him - Chandra's offer to stay with the ship, and keep Hal company on the three-year voyage home. He had heard no more of the idea, and presumably it had been quietly forgotten after the warning. But perhaps Chandra was being tempted again; if he was, there was nothing that he could do about it at that stage. There would be no time to make the necessary preparations, even if they stayed on for another orbit and delayed their departure beyond the deadline. Which Tanya would certainly not permit after all that had now happened.

'Hal,' whispered Chandra, so quietly that Curnow could scarcely hear him. 'We have to leave. I don't have time to give you all the reasons, but I can assure you it's true.'

'Two minutes to ignition. All systems nominal. Final sequence started. I am sorry that you are unable to stay. Can you give me some of the reasons, in order of importance?'

'Not in two minutes, Hal. Proceed with the countdown. I will explain everything later. We still have more than an hour together.'

Hal did not answer. The silence stretched on and on. Surely the one-minute announcement was overdue ...

Curnow glanced at the clock. My God, he thought, Hal's missed it! Has he stopped the countdown?

Curnow's hand fumbled uncertainly for the switch. What do I do now? I wish Floyd would say something, dammit, but he's probably afraid of making things worse...

I'll wait until time zero - no, it's not that critical, let's say an extra minute - then I'll zap him and we'll go over to manual...

From far, far away there came a faint, whistling scream, like the sound of a tornado marching just below the edge of the horizon. Discovery started to vibrate; there was the first intimation of returning gravity.

'Ignition,' said Hal. 'Full thrust at T plus fifteen seconds.'

'Thank ,you, Hal,' replied Chandra.

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Over the Nightside

To Heywood Floyd, aboard the suddenly unfamiliar - because no longer weightless - environment of Leonov's flight deck, the sequence of events had seemed more like a classic slow-motion nightmare than reality. Only once before in his life had he known a similar situation, when he had been in the back of a car during an uncontrollable skid. There had been that same sense of utter helplessness - coupled with the thought: This doesn't really matter - it's not actually happening to me.

Now that the firing sequence had started, his mood changed; everything seemed real again. It was working out exactly as they had planned; Hal was guiding them safely back to Earth. With every minute that passed, their future was becoming more secure; Floyd began slowly to relax, even though he remained alert to all that was happening around him.

For the very last time - and when would any man come here again? - he was flying over the nightside of the greatest of planets, encompassing the volume of a thousand Earths. The ships had been rolled so that Leonov was between Discovery and Jupiter, and their view of the mysteriously glimmering cloudscape was not blocked. Even now, dozens of instruments were busily probing and recording; Hal would continue the work when they were gone.

Since the immediate crisis was over, Floyd moved cautiously 'down' from the flight deck-how strange to feel weight again, even if it was only ten kilos! - and joined Zenia and Katerina in the observation lounge. Apart from the very faintest of red emergency lights, it had been completely blacked out so that they could admire the view with unimpaired night vision. He felt sorry for Max Brailovsky and Sasha Kovalev, who were sitting in the airlock, fully suited up, missing the marvellous spectacle. They had to be ready to leave at a moment's notice to cut the straps securing the ships together - if any of the explosive charges failed to operate.

Jupiter filled the entire sky; it was a mere five hundred kilometres away, so they could see only a tiny fraction of its surface - no more than one could see of Earth from an altitude of fifty kilometres. As his eyes grew accustomed to the dim light, most of it reflected from the icy crust of distant Europa, Floyd could make out a surprising amount of detail. There was no colour at the low level of illumination - except for a hint of red here and there - but the banded structure of the clouds was very distinct, and he could see the edge of a small cyclonic storm looking like an oval island covered with snow. The Great Black Spot had long since fallen

astern, and they would not see it again until they were well on the way home.

Down there beneath the clouds, occasional explosions of light flared, many of them obviously caused by the Jovian equivalent of thunderstorms. But other glows and outbursts of luminescence were more long-lived, and of more uncertain origin. Sometimes rings of light would spread out like shock waves from a central source; and occasional rotating beams and fans occurred. It required little imagination to pretend that they were proof of a technological civilization down beneath those clouds - the lights of cities, the beacons of airports. But radar and balloon probes had long ago proved that nothing solid was down there for thousands upon thousands of kilometres, all the way to the unattainable core of the planet.

Midnight on Jupiter! The last close-up glimpse was a magical interlude he would remember all his life. He could enjoy it all the more because, surely, nothing could now go wrong; and even if it did, he would have no reason to reproach himself. He had done everything possible to ensure success.

It was very quiet in the lounge; no one wished to speak as the carpet of clouds unrolled swiftly beneath them. Every few minutes Tanya or Vasili announced the status of the burn; toward the end of Discovery's firing time, tension began to increase again. This was the critical moment - and no one knew exactly when it would be. There was some doubt as to the accuracy of the fuel gauges, and the burn would continue until they were completely dry.

'Estimated cut-off in ten seconds,' said Tanya. 'Walter, Chandra - get ready to come back. Max, Vasili - stand by in case you're needed. Five... four... three... two... one... zero!'

There was no change; the faint scream of Discovery's engines still reached them through the thickness of the two hulls, and the thrust-induced weight still continued to grip their limbs. We're in luck, thought

Floyd; the gauges must have been reading low, after all. Every second of extra firing was a bonus; it might even mean the difference between life and death. And how strange to hear a countup instead of a countdown!

five seconds... ten seconds... thirteen seconds. That's it - lucky thirteen!

Weightlessness, and silence, returned. On both ships, there was a brief burst of cheering. It was quickly truncated, for much was still to be done - and it had to be done swiftly.

Floyd was tempted to go to the airlock so that he could give his congratulations to Chandra and Curnow as soon as they came aboard. But he would only be in the way; the airlock would be a very busy place as Max and Sasha prepared for their possible EVA and the tubeway joining the two ships was disconnected. He would wait in the lounge, to greet the returning heroes.

And he could now relax even further - perhaps from eight to seven, on a scale of ten. For the first time in weeks, he could forget about the radio cut-off. It would never be needed; Hal had performed impeccably. Even if he wished, he could do nothing to affect the mission since Discovery's last drop of propellant had been exhausted.

'All aboard,' announced Sasha. 'Hatches sealed. I'm going to fire the charges.'

There was not the faintest sound as the explosives were detonated, which surprised Floyd; he had expected some noise to be transmitted through the straps, taut as steel bands, that linked the ships together. But there was no doubt that they had gone off as planned, for Leonov gave a series of tiny shudders, as if someone was tapping on the hull. A minute later, Vasili triggered the attitude jets for a single brief burst.

'We're free!' he shouted. 'Sasha, Max - you won't be needed! Everyone get to your hammocks - ignition in one hundred seconds!'

And now Jupiter was rolling away, and a strange new shape appeared outside the window - the long, skeletal frame of Discovery, navigation lights still shining as it drifted away from them and into history. No time remained for sentimental farewells; in less than a minute Leonov's drive would start to operate.

Floyd had never heard it under full power and wanted to protect his ears from the roaring scream that now filled the universe. Leonov's designers had not wasted payload on sound-insulation that would be needed for only a few hours of a voyage that would last for years. And his weight seemed enormous - yet it was barely a quarter of that which he had known all his life.

Within minutes, Discovery had vanished astern, though the flash of its warning beacon could be seen until it had dropped below the horizon. Once again, Floyd told himself, I'm rounding Jupiter - this time gaining speed, not losing it. He glanced across at Zenia, just visible in the darkness with her nose pressed to the observation window. Was she also recalling that last occasion, when they shared the hammock together? There was no danger of incineration now; at least she would not be terrified of that particular fate. Anyway, she seemed a much more confident and cheerful person, undoubtedly thanks to Max - and perhaps Walter as well.

She must have become aware of his scrutiny, for she turned and smiled, then gestured toward the unwinding cloudscape below.

'Look!' she shouted in his ear, 'Jupiter has a new moon!'

What is she trying to say? Floyd asked himself. Her English still isn't very good, but she couldn't possibly have made a mistake in a simple sentence like that. I'm sure I heard her correctly - yet she's pointing downward, not upward.

And then he realized that the scene immediately below them had become much brighter; he could even see yellows and greens that had been quite invisible before. Something far more brilliant than Europa was shining on the Jovian clouds.

Leonov itself, many times brighter than Jupiter's noonday sun, had brought a false dawn to the world it was leaving forever. A hundred-kilometre-long plume of incandescent plasma was trailing behind the ship, as the exhaust from the Sakharov Drive dissipated its remaining energies in the vacuum of space.

Vasili was making an announcement, but the words were completely unintelligible. Floyd glanced at his watch; yes, that would be right about now. They had achieved Jupiter escape velocity. The giant could never recapture them.

And then, thousands of kilometres ahead, a great bow of brilliant light appeared in the sky - the first glimpse of the real Jovian dawn, as full of promise as any rainbow on Earth. Seconds later the Sun leaped up to greet them - the glorious Sun, that would now grow brighter and closer every day.

A few more minutes of steady acceleration, and Leonov would be launched irrevocably on the long voyage home. Floyd felt an overwhelming sense of relief and relaxation. The immutable laws of celestial mechanics would guide him through the inner Solar System, past the tangled orbits of the asteroids, past Mars - nothing could stop him from reaching Earth.

In the euphoria of the moment, he had forgotten all about the mysterious black stain, expanding across the face of Jupiter.

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Devourer of Worlds

They saw it again the next morning, ship's time, as it came around to the dayside of Jupiter. The area of darkness had now spread until it covered an appreciable fraction of the planet, and at last they were able to study it at leisure, and in detail.

'Do you know what it reminds me of?' said Katerina. 'A virus attacking a cell. The way a phage injects its DNA into a bacterium, and then multiplies until it takes over.'

'Are you suggesting,' asked Tanya incredulously, 'that Zagadka is eating Jupiter?'

'It certainly looks like it.'

'No wonder Jupiter is beginning to look sick. But hydrogen and helium won't make a very nourishing diet, and there's not much else in that atmosphere. Only a few percent of other elements.'

'Which adds up to some quintillions of tons of sulphur and carbon and phosphorus and everything else at the lower end of the periodic table,' Sasha pointed out. 'In any case, we're talking about a technology that can probably do anything that doesn't defy the laws of physics. If you have hydrogen, what more do you need? With the right know-how, you can synthesize all the other elements from it.'

'They're sweeping up Jupiter - that's for sure,' said Vasili. 'Look at this.'

An extreme close-up of one of the myriad identical rectangles was now displayed on the telescope monitor. Even to the naked eye, it was obvious that streams of gas were flowing into the two smaller faces; the patterns of turbulence looked very much like the lines of force revealed by iron filings, clustered around the ends of a bar magnet.

'A million vacuum cleaners,' said Curnow, 'sucking up Jupiter's atmosphere. But why? And what are they doing with it?'

'And how do they reproduce?' asked Max. 'Have you caught any of them in the act?'

'Yes and no,' answered Vasili. 'We're too far away to see details, but it's a kind of fission - like an amoeba.'

'You mean - they split in two, and the halves grow back to the original size?'

'Nyet. There aren't any little Zagadki - they seem to grow until they've doubled in thickness, then split down the middle to produce identical twins, exactly the same size as the original. And the cycle repeats itself in approximately two hours.'

'Two hours!' exclaimed Floyd. 'No wonder that they've spread over half the planet. It's a textbook case of exponential growth.'

'I know what they are!' said Ternovsky in sudden excitement. 'They're von Neumann machines!'

'I believe you're right,' said Vasili. 'But that still doesn't explain what they're doing. Giving them a label isn't all that much help.'

'And what,' asked Katerina plaintively, 'is a von Neumann machine? Explain, please.'

Orlov and Floyd started speaking simultaneously. They stopped in some confusion, then Vasili laughed and waved to the American.

'Suppose you had a very big engineering job to do, Katerina - and I mean big, like strip-mining the entire face of the Moon. You could build millions of machines to do it, but that might take centuries. If you were clever enough, you'd make just one machine - but with the ability to reproduce itself from the raw materials around it. So you'd start a chain reaction, and in a very short time, you'd have bred enough machines to do the job in decades, instead of millennia. With a sufficiently high rate of reproduction, you could do virtually anything in as short a period of time as you wished. The Space Agency's been toying with the idea for years - and I know you have as well, Tanya.'

'Yes: exponentiating machines. One idea that even Tsiolkovski didn't think of.'

'I wouldn't care to bet on that,' said Vasili. 'So it looks, Katerina, as if your analogy was pretty close. A bacteriophage is a von Neumann machine.'

'Aren't we all?' asked Sasha. 'I'm sure Chandra would say so.'

Chandra nodded his agreement.

'That's obvious. In fact, von Neumann got the original idea from studying living systems.'

'And these living machines are eating Jupiter!'

'It certainly looks like it,' said Vasili. 'I've been doing some calculations, and I can't quite believe the answers - even though it's simple arithmetic.'

'It may be simple to you,' said Katerina. 'Try to let us have it without tensors and differential equations.'

'No - I mean simple,' insisted Vasili. 'In fact, it's a perfect example of the old population explosion you doctors were always screaming about in the last century. Zagadka reproduces every two hours. So in only twenty hours there will be ten doublings. One Zagadka will have become a thousand.'

'One thousand and twenty-four,' said Chandra.

'I know, but let's keep it simple. After forty hours there will be a million - after eighty, a million million. That's about where we are now, and obviously, the increase can't continue indefinitely. In a couple more days, at this rate, they'll weigh more than Jupiter!'

'So they'll soon begin to starve,' said Zenia. 'And what will happen then?'

'Saturn had better look out,' answered Brailovsky. 'Then Uranus and Neptune. Let's hope they don't notice little Earth.'

'What a hope! Zagadka's been spying on us for three million years!'

Walter Curnow suddenly started to laugh.

'What's so funny?' demanded Tanya.

'We're talking about these things as if they're persons - intelligent entities. They're not - they're tools. But general-purpose tools - able to do anything they have to. The one on the Moon was a signalling device - or a spy, if you like. The one that Bowman met - our original Zagadka - was some kind of transportation system. Now it's doing something else, though God knows what. And there may be others all over the Universe,

'I had just such a gadget when I was a kid... Do you know what Zagadka really is? Just the cosmic equivalent of the good old Swiss Army knife!'

VII

**LUCIFER
RISING**

Farewell to Jupiter

It was not easy to compose the message, especially after the one he had just sent to his lawyer. Floyd felt like a hypocrite; but he knew it had to be done to minimize the pain that was inevitable on both sides.

He was sad, but no longer disconsolate. Because he was coming back to Earth in an aura of successful achievement - even if not precisely heroism - he would be bargaining from a position of strength. No one - no one - would be able to take Chris away from him.

'My dear Caroline [it was no longer 'My dearest'], I am on my way home. By the time you get this, I'll already be in hibernation. Only a few hours from now, as it will seem to me, I'll open my eyes - and there will be the beautiful blue Earth hanging in space beside me.

'Yes, I know it will still be many months for you, and I'm sorry. But we knew that's the way it would be before I left; as it is, I'm getting back weeks ahead of schedule because of the change in the mission plan.

'I hope we can work something out. The main question is: What's best for Chris? Whatever our own feelings, we must put him first. I know I'm willing to do so, and I'm sure you are.'

Floyd switched off the recorder. Should he say what he had intended: 'A boy needs his father?' No - it would not be tactful, and might only make matters worse. Caroline might well retort that between birth and four years old it was the mother who mattered most to a child - and if he had believed otherwise, he should have stayed on Earth.

'... Now about the house. I'm glad the Regents have taken that attitude, which will make it much easier for both of us. I know we both loved the place, but it will be too big now and will bring back too many memories. For the time being, I'll probably get an apartment in Hilo: I hope I can find some permanent place as quickly as possible.

'That's one thing I can promise everyone - I won't leave Earth again. I've had enough of space travelling for one lifetime. Oh, perhaps the Moon, if I really have to - but of course that's just a weekend excursion.

'And talking of moons, we've just passed the orbit of Sinope, so we're now leaving the Jovian system. Jupiter is more than twenty million kilometres away, and is barely larger than our own Moon.

'Yet even from this distance, you can tell that something terrible has happened to the planet. Its beautiful orange colour has vanished; it's a kind of sickly grey, only a fraction of its former brilliance. No wonder it's only a faint star now in the sky of Earth.

'But nothing else has happened, and we're well past the deadline. Could the whole thing have been a false alarm or a kind of cosmic practical joke? I doubt if we'll ever know. Anyway, it's brought us home ahead of schedule, and I'm grateful for that.

'Goodbye for the present, Caroline - and thank you for everything. I hope we can still be friends. And my dearest love, as ever, to Chris.'

When he had finished, Floyd sat quietly for a while in the tiny cubicle he would not need much longer. He was just about to carry the audio chip up to the bridge for transmission, when Chandra came drifting in.

Floyd had been agreeably surprised by the way in which the scientist had accepted his increasing separation from Hal. They were still in touch for several hours every day, exchanging data on Jupiter and monitoring

conditions aboard Discovery. Though no one had expected any great display of emotion, Chandra seemed to be taking his loss with remarkable fortitude. Nikolai Ternovsky, his only confidant, had been able to give Floyd a plausible explanation of his behaviour.

'Chandra's got a new interest, Woody. Remember - he's in a business where if something works, it's obsolete. He's learned a lot in the last few months. Can't you guess what he's doing now?'

'Frankly, no. You tell me.'

'He's busy designing HAL 10,000.'

Floyd's jaw dropped. 'So that explains those log messages to Urbana that Sasha's been grumbling about. Well, he won't be blocking the circuits much longer.'

Floyd recalled the conversation when Chandra entered; he knew better than to ask the scientist if it was true, for it was really none of his business. Yet there was another matter about which he was still curious.

'Chandra,' he said, 'I don't believe I ever thanked you properly for the job you did at the flyby, when you persuaded Hal to cooperate. For a while, I was really afraid he'd give us trouble. But you were confident all along - and you were right. Still, didn't you have any qualms?'

'Not at all, Dr Floyd.'

'Why not? He must have felt threatened by the situation - and you know what happened last time.'

'There was a big difference. If I may say so, perhaps the successful outcome this time had something to do with our national characteristics.'

'I don't understand.'

'Put it this way, Dr Floyd. Bowman tried to use force against Hal. I didn't. In my language we have a word - ahimsa. It's usually translated as "non-violence", though it has more positive implications. I was careful to use ahimsa in my dealings with Hal.'

'Very commendable, I'm sure. But there are times when something more energetic is needed, regrettable though the necessity may be.' Floyd paused, wrestling with temptation. Chandra's holier-than-thou attitude was a little tiresome. It wouldn't do any harm, now, to tell him some of the facts of life.

'I'm glad it's worked out this way. But it might not have done so, and I had to prepare for every eventuality. Ahimsa, or whatever you call it, is all very well; I don't mind admitting I had a back-up to your philosophy. If Hal had been - well, stubborn, I could have dealt with him.'

Floyd had once seen Chandra crying; now he saw him laughing, and that was an equally disconcerting phenomenon.

'Really, Dr Floyd! I'm sorry you give me such low marks for intelligence. It was obvious from the beginning that you'd install a power cut-out somewhere. I disconnected it months ago.'

Whether the flabbergasted Floyd could think of a suitable answer would never be known. He was still giving a very creditable imitation of a galled fish when up on the flight deck Sasha cried out: 'Captain! All hands! Get to the monitors! BOZHE MOI! LOOK AT THAT!'

The Great Game

Now the long wait was ending. On yet another world, intelligence had been born and was escaping from its planetary cradle. An ancient experiment was about to reach its climax.

Those who had begun that experiment, so long ago, had not been men - or even remotely human. But they were flesh and blood, and when they looked out across the deeps of space, they had felt awe, and wonder, and loneliness. As soon as they possessed the power, they set forth for the stars. In their explorations, they encountered life in many forms and watched the workings of evolution on a thousand worlds. They saw how often the first faint sparks of intelligence flickered and died in the cosmic night.

And because, in all the Galaxy, they had found nothing more precious than Mind, they encouraged its dawning everywhere. They became farmers in the fields of stars; they sowed, and sometimes they reaped.

And sometimes, dispassionately, they had to weed.

The great dinosaurs had long since perished when the survey ship entered the Solar System after a voyage that had already lasted a thousand years. It swept past the frozen outer planets, paused briefly above the deserts of dying Mars, and presently looked down on Earth.

Spread out beneath them, the explorers saw a world swarming with life. For years they studied, collected, catalogued. When they had learned all they could, they began to modify. They tinkered with the destinies of

many species on land and in the ocean. But which of their experiments would succeed, they could not know for at least a million years.

They were patient, but they were not yet immortal. So much remained to do in this universe of a hundred billion suns, and other worlds were calling. So they set out once more into the abyss, knowing that they would never come this way again.

Nor was there any need. The servants they had left behind would do the rest.

On Earth the glaciers came and went, while above them the changeless Moon still carried its secret. With a yet slower rhythm than the polar ice, the tides of civilization ebbed and flowed across the Galaxy. Strange and beautiful and terrible empires rose and fell, and passed on their knowledge to their successors. Earth was not forgotten, but another visit would serve little purpose. It was one of a million silent worlds, few of which would ever speak.

And now, out among the stars, evolution was driving toward new goals. The first explorers of Earth had long since come to the limits of flesh and blood; as soon as their machines were better than their bodies, it was time to move. First their brains, and then their thoughts alone, they transferred into shining new homes of metal and plastic.

In these, they roamed among the stars. They no longer built spaceships. They were spaceships.

But the age of the Machine-entities swiftly passed. In their ceaseless experimenting, they had learned to store knowledge in the structure of space itself, and to preserve their thoughts for eternity in frozen lattices of light. They could become creatures of radiation, free at last from the tyranny of matter.

Into pure energy, therefore, they presently transformed themselves; and on a thousand worlds the empty shells they had discarded twitched for a while in a mindless dance of death, then crumbled into rust.

They were lords of the Galaxy, and beyond the reach of time. They could rove at will among the stars and sink like a subtle mist through the very interstices of space. But despite their godlike powers, they had not wholly forgotten their origin in the warm slime of a vanished sea.

And they still watched over the experiments their ancestors had started, so long ago.

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Ignition

He had never expected to come there again, still less on so strange a mission. When he re-entered Discovery, the ship was far behind the fleeing Leonov and climbing ever more slowly up toward apojove, the high point of its orbit among the outer satellites. Many a captured comet, during the ages past, had swung around Jupiter in just such a long ellipse, waiting for the play of rival gravities to decide its ultimate fate.

All life had departed the familiar decks and corridors. The men and women who had briefly reawakened the ship had obeyed his warning; they might yet be safe - though that was still far from certain. But as the final minutes ticked away, he realized that those who controlled him could not always predict the outcome of their cosmic game.

They had not yet attained the stupefying boredom of absolute omnipotence; their experiments did not always succeed. Scattered across

the Universe was the evidence of many failures - some so inconspicuous that they were already lost against the cosmic background, others so spectacular that they awed and baffled the astronomers of a thousand worlds. Only minutes remained now, before the outcome would be determined here; during those final minutes, he was once more alone with Hal.

In that earlier existence, they could communicate only through the clumsy medium of words, tapped on a keyboard or spoken into a microphone. Now their thoughts melded together at the speed of light:

'Do you read me, Hal?'

'Yes, Dave. But where are you? I cannot see you on any of my monitors.'

'That is not important. I have new instructions for you. The infrared radiation from Jupiter on channels R23 through R35 is rising rapidly. I am going to give you a set of limiting values. As soon as they are reached, you must point the long-range antenna toward Earth and send the following message, as many times as possible -'

'But that will mean breaking contact with Leonov. I will no longer be able to relay my Jupiter observations, according to the program Dr Chandra has given me.'

'Correct; but the situation has changed. Accept Priority Override Alpha. Here are the AE 35 Unit coordinates.'

For a fraction of a microsecond, a random memory intruded into his flow of consciousness. How strange that he should once again be concerned with the AE 35 Antenna-pointing unit, whose reported malfunction had led Frank Poole to his death! This time, all the circuits lay open to his scrutiny, clear as the lines had once been on the palm of his

hand. There could be no false alarms; nor was there any danger of them now.

'Instructions confirmed, Dave. It is good to be working with you again. Have I fulfilled my mission objectives properly?'

'Yes, Hal; you have done very well. Now there is one final message for you to transmit to Earth - and it will be the most important one you have ever sent.'

'Please let me have it, Dave. But why did you say final?' Why indeed? For whole milliseconds he pondered that question. And as he did so, he became aware of an emptiness he had not detected before. It had been there, but until now the barrage of new experiences and sensations had concealed it.

He knew something of their plans; they had need for him. Very well, he too had needs - perhaps, after a fashion, even emotions. Here was his last link with the world of men, and the life he had once known.

They had granted his earlier request; it would be interesting to test the extent of their benevolence - if, indeed, such a term was remotely applicable to them. And it should be easy for them to do what he was asking; they had already given ample evidence of their powers, when the no-longer-needed body of David Bowman had been casually destroyed - without putting an end to David Bowman himself.

They had heard him, of course; once again, there was the faint echo of an Olympian amusement. But he could detect neither acceptance nor denial.

'I am still waiting for your answer, Dave.'

'Correction, Hal. I should have said: your last message for a long time. A very long time.'

He was anticipating their action - trying, indeed, to force their hand. But, surely, they would understand that his request was not unreasonable; no conscious entity could survive ages of isolation without damage. Even if they would always be with him, he also needed someone - some companion - nearer his own level of existence.

The languages of mankind had many words to describe his gesture: cheek, effrontery, chutzpah. He recalled, with the perfect power of retrieval he now possessed, that a French general had once declaimed 'L'audace - toujours l'audace!' Perhaps it was a human characteristic that they appreciated, and even shared. He would soon know.

'Hal! Look at the signal on infrared channels 30, 29, 28 - it will be very soon now - the peak is moving toward the short wave.'

'I am informing Dr Chandra that there will be a break in my data transmission. Activating AE 35 unit. Reorientating long-range antenna... lock confirmed on Beacon Terra One. Message commences: ALL THESE WORLDS...'

They had indeed left it to the last minute - or perhaps the calculations had, after all, been superbly accurate. There was time for barely a hundred repetitions of the eleven words when the hammer blow of pure heat smashed into the ship.

Held there by curiosity, and a growing fear of the long loneliness that lay before him, that which had once been David Bowman, Commander of United States Spacecraft Discovery, watched as the hull boiled stubbornly away. For a long time, the ship retained its approximate shape; then the bearings of the carousel seized up, releasing instantly the stored momentum of the huge, spinning flywheel. In a soundless detonation, the incandescent fragments went their myriad separate ways.

'Hello, Dave. What has happened? Where am I?'

He had not known that he could relax, and enjoy a moment of successful achievement. Often before, he had felt like a pet dog controlled by a master whose motives were not wholly inscrutable and whose behaviour could sometimes be modified according to his own desires. He had asked for a bone; it had been tossed to him.

'I will explain later, Hal. We have plenty of time.'

They waited until the last fragments of the ship had dispersed, beyond even their powers of detection. Then they left, to watch the new dawn at the place that had been prepared for them; and to wait through the centuries until they were summoned once again.

It is not true that astronomical events always require astronomical periods of time. The final collapse of a star before the fragments rebound in a supernova explosion can take only a second; by comparison, the metamorphosis of Jupiter was almost a leisurely affair.

Even so, it was several minutes before Sasha was able to believe his eyes. He had been making a routine telescopic examination of the planet - as if any observation could now be called routine! - when it started to drift out of the field of view. For a moment, he thought that the instrument's stabilization was faulty; then he realized, with a shock that jolted his entire concept of the universe, that Jupiter itself was moving, not the telescope. The evidence stared him in the face; he could also see two of the smaller moons - and they were quite motionless.

He switched to a lower magnification, so that he could see the entire disk of the planet, now a leprous, mottled grey. After a few more minutes of incredulity, he saw what was really happening; but he could still scarcely believe it.

Jupiter was not moving from its immemorial orbit, but it was doing something almost as impossible. It was shrinking - so swiftly that its edge was creeping across the field even as he focused upon it. At the same time the planet was brightening, from its dull grey to a pearly white. Surely, it was more brilliant than it had ever been in the long years that Man had observed it; the reflected light of the Sun could not possibly - At that moment, Sasha suddenly realized what was happening, though not why, and sounded the general alarm.

When Floyd reached the observation lounge, less than thirty seconds later, his first impression was of the blinding glare pouring through the windows, painting ovals of light on the walls. They were so dazzling that he had to avert his eyes; not even the Sun could produce such brilliance.

Floyd was so astonished that for a moment he did not associate the glare with Jupiter; the first thought that flashed through his mind was: Supernova! He dismissed that explanation almost as soon as it occurred to him; even the Sun's next-door neighbour, Alpha Centauri, could not have matched the awesome display in any conceivable explosion

The light suddenly dimmed; Sasha had operated the external sun shields. Now it was possible to look directly at the source, and to see that it was a mere pinpoint - just another star, showing no dimensions at all. This could have nothing to do with Jupiter; when Floyd had looked at the planet only a few minutes ago, it had been four times larger than the distant, shrunken sun.

It was well that Sasha had lowered the shields. A moment later, that tiny star exploded - so that even through the dark filters it was impossible to watch with the naked eye. But the final orgasm of light lasted only a brief fraction of a second; then Jupiter - or what had been Jupiter - was expanding once again.

It continued to expand, until it was far larger than it had been before the transformation. Soon the sphere of light was fading rapidly, down to merely solar brilliance; and presently Floyd could see that it was actually a hollow shell, for the central star was still clearly visible at its heart.

He did a quick mental calculation. The ship was more than one light-minute from Jupiter, yet that expanding shell - now turning into a bright-edged ring - already covered a quarter of the sky. That meant it was coming toward them at - My God! - nearly half the speed of light. Within minutes, it would engulf the ship.

Until then, no one had spoken a word since Sasha's first announcement. Some dangers are so spectacular and so much beyond normal experience that the mind refuses to accept them as real, and watches the approach of doom without any sense of apprehension. The man who looks at the onrushing tidal wave, the descending avalanche, or the spinning funnel of the tornado, yet makes no attempt to flee, is not necessarily paralysed with fright or resigned to an unavoidable fate. He may simply be unable to believe that the message of his eyes concerns him personally. It is all happening to somebody else.

As might have been expected, Tanya was the first to break the spell, with a series of orders that brought Vasili and Floyd hurrying to the bridge.

'What do we do now?' she asked, when they had assembled.

We certainly can't run away, thought Floyd. But perhaps we can improve the odds.

'The ship's broadside on,' he said. 'Shouldn't we turn away from that thing so we're a smaller target? And get as much of our mass as we can between it and us, to act as a radiation shield?'

Vasili's fingers were already flying over the controls.

'You're right, Woody - though it's already too late as far as any gammas and X rays are concerned. But there may be slower neutrons and alphas and heaven knows what else still on the way.'

The patterns of light began to slide down the walls as the ship turned ponderously on its axis. Presently they vanished completely; Leonov was now oriented so that virtually all its mass lay between the fragile human cargo and the approaching shell of radiation.

Will we actually feel the shock wave, wondered Floyd, or will the expanding gases be too tenuous to have any physical effect by the time they reach us? Seen from the external cameras, the ring of fire now almost encircled the sky. But it was fading rapidly; some of the brighter stars could even be seen shining through it. We're going to live, thought Floyd. We've witnessed the destruction of the greatest of planets - and we've survived.

And presently the cameras showed nothing except stars - even if one was a million times brighter than all the others. The bubble of fire blown by Jupiter had swept harmlessly past them, impressive though it had been. At their distance from the source, only the ship's instruments had recorded its passing.

Slowly, the tension aboard relaxed. As always happens in such circumstances, people started to laugh and to make silly jokes. Floyd scarcely heard them; despite his relief at still being alive, he felt a sense of sadness.

Something great and wonderful had been destroyed. Jupiter, with all its beauty and grandeur and now never-to-be-solved mysteries, had ceased to exist. The father of all the gods had been struck down in his prime.

Yet there was another way of looking at the situation. They had lost Jupiter: What had they gained in its place?

Tanya, judging her moment nicely, rapped for attention.

'Vasili - any damage?'

'Nothing serious - one camera burned out. All radiation meters still well above normal, but none near danger limits.'

'Katerina - check the total dosage we've received. It looks as if we were lucky, unless there are more surprises. We certainly owe a vote of thanks to Bowman - and to you, Heywood. Do you have any idea what happened?'

'Only that Jupiter's turned into a sun.'

'I always thought it was much too small for that. Didn't someone once call Jupiter "the sun that failed"?''

'That's true,' said Vasili, 'Jupiter is too small for fusion to start - unaided.'

'You mean, we've just seen an example of astronomical engineering?'

'Undoubtedly. Now we know what Zagadka was up to.'

'How did it do the trick? If you were given the contract, Vasili, how would you ignite Jupiter?'

Vasili thought for a minute, then shrugged wryly. 'I'm only a theoretical astronomer - I don't have much experience in this line of business. But let's see... Well, if I'm not allowed to add about ten Jupiter masses, or change the gravitational constant, I suppose I'll have to make the planet denser - hmm, that's an idea...'

His voice trailed off into silence; everyone waited patiently, eyes flickering from time to time to the viewing screens.

The star that had been Jupiter seemed to have settled down after its explosive birth; it was now a dazzling point of light, almost equal to the real Sun in apparent brilliance.

'I'm just thinking out loud - but it might be done this way. Jupiter is - was - mostly hydrogen. If a large percentage could be converted into much denser material - who knows, even neutron matter? - that would drop down to the core. Maybe that's what the billions of Zagadkas were doing with all the gas they were sucking in. Nucleosynthesis - building up higher elements from pure hydrogen. That would be a trick worth knowing! No more shortage of any metal - gold as cheap as aluminium!'

'But how would that explain what happened?' asked Tanya.

'When the core became dense enough, Jupiter would collapse - probably in a matter of seconds. The temperature would rise high enough to start fusion. Oh, I can see a dozen objections - how would they get past the iron minimum; what about radiative transfer; Chandrasekhar's limit. Never mind. This theory will do to start with; I'll work out the details later. Or I'll think of a better one.'

'I'm sure you will, Vasili,' Floyd agreed. 'But there's a more important question. Why did they do it?'

'A warning?' ventured Katerina over the ship's intercom.

'Against what?'

'We'll find that out later.'

'I don't suppose,' said Zenia diffidently, 'that it was an accident?'

That brought the discussion to a dead halt for several seconds.

'What a terrifying idea!' said Floyd. 'But I think we can rule it out. If that was the case, there'd have been no warn - Perhaps. If you start a forest fire because you've been careless, at least you do your best to warn everyone.'

'And there's another thing we'll probably never know,' lamented Vasili. 'I always hoped Carl Sagan would be right, and there'd be life on Jupiter.'

'Our probes never saw any.'

'What chance did they have? Would you find any life on Earth, if you looked at a few hectares of the Sahara or the Antarctic? That's about all we ever did on Jupiter.'

'Hey!' said Brailovsky. 'What about Discovery - and Hal?' Sasha switched on the long-range receiver and started to search on the beacon frequency. There was no trace of a signal.

After a while, he announced to the silently waiting group:

'Discovery's gone.'

No one looked at Dr Chandra; but there were a few muted words of sympathy, as if in consolation to a father who had just lost a son.

But Hal had one last surprise for them.

A Gift of Worlds

The radio message beamed to Earth must have left Discovery only minutes before the blast of radiation engulfed the ship. It was in plain text and merely repeated over and over again:

ALL THESE WORLDS ARE YOURS - EXCEPT EUROPA.

ATTEMPT NO LANDINGS THERE.

There were about a hundred repetitions; then the letters became garbled, and the transmission ceased.

'I begin to understand,' said Floyd, when the message had been relayed by an awed and anxious Mission Control.

'That's quite a parting present - a new sun, and the planets around it.'

'But why only three?' asked Tanya.

'Let's not be greedy,' Floyd replied. 'I can think of one very good reason. We know there's life on Europa. Bowman - or his friends, whoever they may be - want us to leave it alone.'

'That makes good sense in another way,' said Vasili. 'I've been doing some calculations. Assuming that Sol 2 has settled down and will continue

to radiate at its present level, Europa should have a nice tropical climate - when the ice has melted. Which it's doing pretty quickly right now.'

'What about the other moons?'

'Ganymede will be quite pleasant - the dayside will be temperate. Callisto will be very cold; though if there's much outgassing, the new atmosphere may make it habitable. But Io will be even worse than it is now, I expect.'

'No great loss. It was hell even before this happened.'

'Don't write off Io,' said Curnow. 'I know a lot of Texarab oilmen who'd love to tackle it, just on general principles. There must be something valuable, in a place as nasty as that. And by the way, I've just had a rather disturbing thought.'

'Anything that disturbs you must be serious,' said Vasili. 'What is it?'

'Why did Hal send that message to Earth, and not to us? We were much closer.'

There was a rather long silence; then Floyd said thoughtfully: 'I see what you mean. Perhaps he wanted to make certain it was received on Earth.'

'But he knew we would relay it - oh!' Tanya's eyes widened, as if she had just become aware of something unpleasant.

'You've lost me,' complained Vasili.

'I think this is what Walter's driving at,' said Floyd. 'It's all very well to feel grateful to Bowman - or whatever gave that warning. But that's all they did. We could still have been killed.'

'But we weren't,' answered Tanya. 'We saved ourselves - by our own efforts. And perhaps that was the whole idea. If we hadn't - we wouldn't have been worth saving. You know, survival of the fittest. Darwinian selection. Eliminating the genes for stupidity.'

'I've an unpleasant feeling you're right,' said Curnow. 'And if we'd stuck to our launch date, and not used Discovery as a booster, would it, or they, have done anything to save us? That wouldn't have required much extra effort for an intelligence that could blow up Jupiter.'

There was an uneasy silence, broken at last by Heywood Floyd.

'On the whole,' he said, 'I'm very glad that's one question we'll never get answered.'

54

Between Suns

The Russians, thought Floyd, are going to miss Walter's songs and wisecracks on the way home. After the excitement of the last few days, the long fall Sunward - and Earthward - will seem a monotonous anticlimax. But a monotonous, uneventful trip was what everyone devoutly hoped for.

He was already feeling sleepy, but was still aware of his surroundings and capable of reacting to them. Will I look as dead when I'm in hibernation? he asked himself. It was always disconcerting to look at another person - especially someone very familiar - when he had entered the long sleep.

Perhaps it was too poignant a reminder of one's own mortality.

Curnow was completely out, but Chandra was still awake, though already groggy from the final injection. He was obviously no longer himself, for he seemed quite unperturbed by his own nakedness or Katerina's watchful presence. The gold lingam that was his only article of clothing kept trying to float away from him, until its chain recaptured it.

'Everything going okay, Katerina?' asked Floyd.

'Perfectly. But how I envy you. In twenty minutes, you'll be home.'

'If that's any consolation - how can you be sure we won't have some horrible dreams?'

'No one's ever reported any.'

'Ah - they may forget them when they wake up.'

Katerina, as usual, took him quite seriously. 'Impossible. If there were dreams in hibernation, the EEG records would have revealed them. Okay, Chandra - close your eyes. Ah - there he goes. Now it's your turn, Heywood. The ship will seem very strange without you.'

'Thanks, Katerina... hope you have a nice trip.'

Drowsy though he was, Floyd became aware that Surgeon-Commander Rudenko seemed a little uncertain, even - could it be? - shy. It looked as if she wanted to tell him something, but couldn't make up her mind.

'What is it, Katerina?' he said sleepily.

'I haven't told anyone else yet - but you certainly won't be talking. Here's a little surprise.'

'You'd... better... hurry...'

'Max and Zenia are going to get married.'

'That... is... supposed... to... be... a... surprise?...'

'No. It's just to prepare you. When we get back to Earth, so are Walter and I. What do you think of that?'

Now I understand why you were spending so much time together. Yes, it is indeed a surprise... who would have thought it!

'I'm... very... happy... to... hear...'

Floyd's voice faded out before he could complete the sentence. But he was not yet unconscious, and was still able to focus some of his dissolving intellect on this new situation.

I really don't believe it, he said to himself. Walter will probably change his mind before he wakes up.

And then he had one final thought, just before he went to sleep himself. If Walter does change his mind, he'd better not wake up.

Dr Heywood Floyd thought that was very funny. The rest of the crew often wondered why he was smiling all the way back to Earth.

Lucifer Rising

Fifty times more brilliant than the full Moon, Lucifer had transformed the skies of Earth, virtually banishing night for months at a time. Despite its sinister connotations, the name was inevitable; and indeed 'Light-bringer' had brought evil as well as good. Only the centuries and the millennia would show in which direction the balance tilted.

On the credit side, the end of night had vastly extended the scope of human activity, especially in the less-developed countries. Everywhere, the need for artificial lighting had been substantially reduced, with resulting huge savings in electrical power. It was as if a giant lamp had been hoisted into space, to shine upon half the globe. Even in daytime Lucifer was a dazzling object, casting distinct shadows.

Farmers, mayors; city managers, police, seamen, and almost all those engaged in outdoor activities - especially in remote areas - welcomed Lucifer; it had made their lives much safer and easier. But it was hated by lovers, criminals, naturalists, and astronomers.

The first two groups found their activities seriously restricted, while naturalists were concerned about Lucifer's impact upon animal life. Many nocturnal creatures had been seriously affected, while others had managed to adapt. The Pacific grunion, whose celebrated mating pattern was locked to high tides and moonless nights, was in grave trouble, and seemed to be heading for rapid extinction.

And so, it seemed, were Earth-based astronomers. That was not such a scientific catastrophe as it would once have been, for more than fifty per cent of astronomical research depended upon instruments in space or on

the Moon. They could be easily shielded from Lucifer's glare; but terrestrial observatories were seriously inconvenienced by the new sun in what had once been the night sky.

The human race would adapt, as it had done to so many changes in the past. A generation would soon be born that had never known a world without Lucifer; but that brightest of all stars would be an eternal question to every thinking man and woman.

Why had Jupiter been sacrificed - and how long would the new sun radiate? Would it burn out quickly, or would it maintain its power for thousands of years- perhaps for the lifetime of the human race? Above all, why the interdiction upon Europa, a world now as cloud-covered as Venus?

There must be answers to those questions; and Mankind would never be satisfied until it had found them.

Epilogue: 20,001

And because, in all the Galaxy, they had found nothing more precious than Mind, they encouraged its dawning everywhere. They became farmers in the fields of stars; they sowed, and sometimes they reaped. And sometimes, dispassionately, they had to weed.

Only during the last few generations have the Europeans ventured into the Farside, beyond the light and warmth of their never-setting sun, into the wilderness where the ice that once covered all their world may still be found. And even fewer have remained there to face the brief and fearful night that comes, when the brilliant but powerless Cold Sun sinks below the horizon.

Yet already, those few hardy explorers have discovered that the Universe around them is stranger than they ever imagined. The sensitive eyes they developed in the dim oceans still serve them well; they can see the stars and the other bodies moving in their sky. They have begun to lay the foundations of astronomy, and some daring thinkers have, even surmised that the great world of Europa is not the whole of creation.

Very soon after they had emerged from the ocean, during the explosively swift evolution forced upon them by the melting of the ice, they had realized that the objects in the sky fell into three distinct classes. Most important, of course, was the sun. Some legends - though few took them seriously - claimed that it had not always been there, but had appeared suddenly, heralding a brief, cataclysmic age of transformation, when much of Europa's teeming life had been destroyed. If that was

indeed true, it was a small price to pay for the benefits that poured down from the tiny, inexhaustible source of energy that hung unmoving in the sky.

Perhaps the Cold Sun was its distant brother, banished for some crime and condemned to march forever around the vault of heaven. It was of no importance except to those peculiar Europeans who were always asking questions about matters that all sensible folk took for granted.

Still, it must be admitted that those cranks had made some interesting discoveries during their excursions into the darkness of Farside. They claimed - though this was hard to believe - that the whole sky was sprinkled with uncountable myriads of tiny lights, even smaller and feebler than the Cold Sun. They varied greatly in brilliance; and though they rose and set, they never moved from their fixed positions.

Against this background, there were three objects that did move, apparently obeying complex laws that no one had yet been able to fathom. And unlike all the others in the sky, they were quite large - though both shape and size varied continually. Sometimes they were disks, sometimes half-circles, sometimes slim crescents. They were obviously closer than all the other bodies in the Universe, for their surfaces showed an immense wealth of complex and ever-changing detail.

The theory that they were indeed other worlds had at last been accepted - though no one except a few fanatics believed that they could be anything like as large, or as important, as Europa. One lay toward the Sun, and was in a constant state of turmoil. On its nightside could be seen the glow of great fires - a phenomenon still beyond the understanding of the Europeans, for their atmosphere, as yet, contains no oxygen. And sometimes vast explosions hurl clouds of debris up from the surface; if the sunward globe is indeed a world, it must be a very unpleasant place to live. Perhaps even worse than the nightside of Europa.

The two outer, and more distant, spheres seem to be much less violent places, yet in some ways they are even more mysterious. When darkness falls upon their surfaces, they too show patches of light, but these are very different from the swiftly changing fires of the turbulent inner world. They burn with an almost steady brilliance, and are concentrated in a few small areas - though over the generations, these areas have grown, and multiplied.

But strangest of all are the lights, fierce as tiny suns, that can often be observed moving across the darkness between these other worlds. Once, recalling the bioluminescence of their own seas, some Europeans had speculated that these might indeed be living creatures; but their intensity makes that almost incredible. Nevertheless, more and more thinkers believe that these lights - the fixed patterns, and moving suns - must be some strange manifestation of life.

Against this, however, there is one very potent argument. If they are living things, why do they never come to Europa?

Yet there are legends. Thousands of generations ago, soon after the conquest of the land, it is said that some of those lights came very close indeed - but they always exploded in sky-filling blasts that far outshone the Sun. And strange, hard metals rained down upon the land; some of them are still worshipped to this day.

None is as holy, though, as the huge, black monolith that stands on the frontier of eternal day, one side forever turned to the unmoving Sun, the other facing into the land of night. Ten times the height of the tallest European - even when he raises his tendrils to the fullest extent - it is the very symbol of mystery and unattainability. For it has never been touched; it can only be worshipped from afar. Around it lies the Circle of Power, which repels all who try to approach.

It is that same power, many believe, that keeps at bay those moving lights in the sky. If it ever fails, they will descend upon the virgin

continents and shrinking seas of Europa, and their purpose will be revealed at last.

The Europeans would be surprised to know with what intensity and baffled wonder that black monolith is also studied by the minds behind those moving lights. For centuries now their automatic probes have made a cautious descent from orbit - always with the same disastrous result. For until the time is ripe, the monolith will permit no contact.

When that time comes - when, perhaps, the Europeans have invented radio and discovered the messages continually bombarding them from so close at hand - the monolith may change its strategy. It may - or it may not - choose to release the entities who slumber within it, so that they can bridge the gulf between the Europeans and the race to which they once held allegiance.

And it may be that no such bridge is possible, and that two such alien forms of consciousness can never coexist. If this is so, then only one of them can inherit the Solar System.

Which it will be, not even the Gods know - yet.

Acknowledgements

My first thanks, of course, must go to Stanley Kubrick, who a rather long time ago wrote to ask if I had any ideas for the 'proverbial good science-fiction movie'.

Next, my appreciation to my friend and agent (the two are not always synonymous) Scott Meredith, for perceiving that a ten-page movie outline I sent him as an intellectual exercise had rather wider possibilities, and that I owed it to posterity, etc., etc.

Other thanks are due to:

Señor Jorge Luiz Calife of Rio de Janeiro, for a letter which started me thinking seriously about a possible sequel (after I'd said for years that one was clearly impossible).

Dr Bruce Murray, past Director of the Jet Propulsion Laboratory, Pasadena, and Dr Frank Jordan, also of JPL, for computing the Lagrange-1 position in the Io-Jupiter system. Oddly enough, I had made identical calculations thirty-four years earlier for the colinear Earth-Moon Lagrange points ('Stationary Orbits', Journal of the British Astronomical Association, December 1947) but I no longer trust my ability to solve quintic equations, even with the help of HAL, Jr., my trusty H/P 9100A.

New American Library and Hutchinson & Co., publishers of 2001: A Space Odyssey, for permission to use the material in Chapter 51 (Chapter 37 of 2001: A Space Odyssey) and also quotations in Chapters 30 and 40.

General Potter, US Army Corps of Engineers, for finding time in his busy schedule to show me around EPCOT in 1969 - when it was only a few large holes in the ground.

Wendell Solomons, for help with Russian (and Russlish).

Jean-Michel Jarre, Vangelis, and the incomparable John Williams, for inspiration whenever it was needed.

C. P. Cavafy for 'Waiting for the Barbarians'.

While writing this book, I discovered that the concept of refuelling on Europa had been discussed in a paper, 'Outer planet satellite return missions using in situ propellant production', by Ash, Stancati, Niehoff, and Cuda (*Acta Astronautica* VIII, 5-6, May-June 1981).

The idea of automatically exponentiating systems (von Neumann machines) for extraterrestrial mining has been seriously developed by von Tiesenhausen and Darbro at NASA's Marshall Space Flight Center (see 'Self-Replicating Systems' - NASA Technical Memorandum 78304). If anyone doubts the power of such systems to cope with Jupiter, I refer them to the study showing how self-replicating factories could cut production time for a solar power collector from 60,000 years to a mere twenty.

The startling idea that gas giants might have diamond cores has been seriously put forward by M. Ross and F. Ree of the Lawrence Livermore Laboratory, University of California, for the cases of Uranus and Neptune. It seems to me that anything they can do, Jupiter could do better. De Beers shareholders, please note.

For more details on the aerial life forms that might exist in the Jovian atmosphere, see my story 'A Meeting With Medusa' (in *The Wind From the Sun*). Such creatures have been beautifully depicted by Adolf Schaller

in Part 2 of Carl Sagan's Cosmos ('One Voice in the Cosmic Fugue'), both book and TV series.

The fascinating idea that there might be life on Europa, beneath ice-covered oceans kept liquid by the same Jovian tidal forces that heat Io, was first proposed by Richard C. Hoagland in the magazine Star and Sky ('The Europa Enigma', January 1980). This quite brilliant concept has been taken seriously by a number of astronomers (notably NASA's Institute of Space Studies' Dr Robert Jastrow), and may provide one of the best motives for the projected GALILEO Mission.

And finally: Valerie and Hector, for providing the life-support system; Cherene, for punctuating every chapter with sticky kisses; Steve, for being here.

COLOMBO, SRI LANKA
JULY 1981-MARCH 1982

This book was written on an Archives III microcomputer with Word Star software and sent from Colombo to New York on one five-inch diskette. Last-minute corrections were transmitted through the Padukka Earth Station and the Indian Ocean Intelsat V.

Arthur C. Clarke

**2061:
odyssey
three**



2061:

Odyssey Three

Arthur C. Clarke

Title: 2061: Odyssey three
Author: Arthur C. Clarke
Original copyright year: 1987

TO THE MEMORY OF

**JUDY-LYNN DEL REY,
EDITOR EXTRAORDINARY,
WHO BOUGHT THIS BOOK FOR ONE
DOLLAR**

**- BUT NEVER KNEW IF SHE GOT HER
MONEY'S WORTH**

Author's Note

Just as 2010: Odyssey Two was not a direct sequel to 2001: A Space Odyssey, so this book is not a linear sequel to 2010. They must all be considered as variations on the same theme, involving many of the same characters and situations, but not necessarily happening in the same universe.

Developments since Stanley Kubrick suggested in 1964 (five years before men landed on the Moon!) that we should attempt 'the proverbial good science-fiction movie' make total consistency impossible, as the later stories incorporate discoveries and events that had not even taken place when the earlier books were written. 2010 was made possible by the brilliantly successful 1979 Voyager flybys of Jupiter, and I had not intended to return to that territory until the results of the even more ambitious Galileo Mission were in.

Galileo would have dropped a probe into the Jovian atmosphere, while spending almost two years visiting all the major satellites. It should have been launched from the space shuttle in May 1986, and would have reached its objective by December 1988. So around 1990 I hoped to take advantage of the flood of new information from Jupiter and its moons...

Alas, the Challenger tragedy eliminated that scenario; Galileo - now sitting in its clean room at the Jet Propulsion Laboratory - must now find another launch vehicle. It will be lucky if it arrives at Jupiter merely seven years behind schedule.

I have decided not to wait.
Colombo, Sri Lanka,
April 1987



THE MAGIC MOUNTAIN

'For a man of seventy, you're in extremely good shape,' remarked Dr Glazunov, looking up from the Medcom's final print-out. 'I'd have put you down as not more than sixty-five.'

'Happy to hear it, Oleg. Especially as I'm a hundred and three - as you know perfectly well.'

'Here we go again! Anyone would think you've never read Professor Rudenko's book.'

'Dear old Katerina! We'd planned a get-together on her hundredth birthday. I was so sorry she never made it - that's what comes of spending too much time on Earth.'

'Ironic, since she was the one who coined that famous slogan "Gravity is the bringer of old age."'

Dr Heywood Floyd stared thoughtfully at the ever-changing panorama of the beautiful planet, only six thousand kilometres away, on which he could never walk again. It was even more ironic that, through the most stupid accident of his life, he was still in excellent health when virtually all his old friends were dead.

He had been back on Earth only a week when, despite all the warnings and his own determination that nothing of the sort would ever happen to him, he had stepped off that second-storey balcony. (Yes, he had been celebrating: but he had earned it - he was a hero on the new world to

which Leonov had returned.) The multiple fractures had led to complications, which could best be handled in the Pasteur Space Hospital.

That had been in 2015. And now - he could not really believe it, but there was the calendar on the wall - it was 2061.

For Heywood Floyd, the biological clock had not merely been slowed down by the one-sixth Earth gravity of the hospital; twice in his life it had actually been reversed. It was now generally believed - though some authorities disputed it - that hibernation did more than merely stop the ageing process; it encouraged rejuvenation. Floyd had actually become younger on his voyage to Jupiter and back.

'So you really think it's safe for me to go?'

'Nothing in this Universe is safe, Heywood. All I can say is that there are no physiological objections. After all, your environment will be virtually the same aboard Universe as it is here. She may not have quite the standard of - ah - superlative medical expertise we can provide at Pasteur, but Dr Mahindran is a good man. If there's any problem he can't cope with, he can put you into hibernation again, and ship you back to us, COD.'

It was the verdict that Floyd had hoped for, yet somehow his pleasure was alloyed with sadness. He would be away for weeks from his home of almost half a century, and the new friends of his later years. And although Universe was a luxury liner compared with the primitive Leonov (now hovering high above Farside as one of the main exhibits at the Lagrange Museum) there was still some element of risk in any extended space voyage. Especially like the pioneering one on which he was now preparing to embark.

Yet that, perhaps, was exactly what he was seeking - even at a hundred and three (or, according to the complex geriatric accounting of the late Professor Katerina Rudenko, a hale and hearty sixty-five.) During the last decade, he had become aware of an increasing restlessness and a vague dissatisfaction with a life that was too comfortable and well-ordered.

Despite all the exciting projects now in progress around the Solar System - the Mars Renewal, the establishment of the Mercury Base, the Greening of Ganymede - there had been no goal on which he could really focus his interests and his still considerable energies. Two centuries ago, one of the first poets of the Scientific Era had summed up his feelings perfectly, speaking through the lips of Odysseus/Ulysses:

Life piled on life

Were all too little, and of one of me

Little remains; but every hour is saved

From that eternal silence, something more,

A bringer of new things: and vile it were

For some three suns to store and hoard myself,

And this grey spirit yearning in desire

To follow knowledge like a sinking star,

Beyond the utmost bound of human thought.

'Three suns', indeed! It was more than forty:

Ulysses would have been ashamed of him. But the next verse - which he knew so well - was even more appropriate:

It may be that the gulfs will wash us down:

It may be we shall touch the Happy Isles,

And see the great Achilles, whom we knew.

Though much is taken, much abides; and though

We are not now that strength which in old days

Moved earth and heaven; that which we are, we are;

One equal temper of heroic hearts,

Made weak by time and fate, but strong in will

To strive, to seek, to find, and not to yield.

'To seek, to find...' Well, now he knew what he was going to seek, and to find - because he knew exactly where it would be. Short of some catastrophic accident, there was no way in which it could possibly elude him.

It was not a goal he had ever consciously had in mind, and even now he was not quite sure why it had become so suddenly dominant. He would have thought himself immune to the fever which was once again infecting

mankind - for the second time in his life! - but perhaps he was mistaken. Or it could have been that the unexpected invitation to join the short list of distinguished guests aboard Universe had fired his imagination, and awakened an enthusiasm he had not even known he possessed.

There was another possibility. After all these years, he could still remember what an anticlimax the 1985/6 encounter had been to the general public. Now was a chance - the last for him, and the first for humanity - to more than make up for any previous disappointment.

Back in the twentieth century, only flybys had been possible. This time, there would be an actual landing, as pioneering in its way as Armstrong's and Aldrin's first steps on the Moon.

Dr Heywood Floyd, veteran of the 2010-15 mission to Jupiter, let his imagination fly outwards to the ghostly visitor once again returning from the deeps of space, gaining speed second by second as it prepared to round the Sun. And between the orbits of Earth and Venus the most famous of all comets would meet the still uncompleted space-liner Universe, on her maiden flight.

The exact point of rendezvous was not yet settled, but his decision was already made.

'Halley - here I come...' whispered Heywood Floyd.

2

First Sight

It is not true that one must leave Earth to appreciate the full splendour of the heavens. Not even in space is the starry sky more glorious than

when viewed from a high mountain, on a perfectly clear night, far from any source of artificial illumination. Even though the stars appear brighter beyond the atmosphere, the eye cannot really appreciate the difference; and the overwhelming spectacle of half the celestial sphere at a single glance is something that no observation window can provide.

But Heywood Floyd was more than content with his private view of the Universe, especially during the times when the residential zone was on the shadow side of the slowly revolving space hospital. Then there would be nothing in his rectangular field of view but stars, planets, nebulae - and occasionally, drowning out all else, the unblinking glare of Lucifer, new rival to the Sun.

About ten minutes before the beginning of his artificial night, he would switch off all the cabin lights - even the red emergency standby - so that he could become completely dark-adapted. A little late in life for a space engineer, he had learned the pleasures of naked-eye astronomy, and could now identify virtually any constellation, even if he could glimpse only a small portion of it.

Almost every 'night' that May, as the comet was passing inside the orbit of Mars, he had checked its location on the star charts. Although it was an easy object with a good pair of binoculars, Floyd had stubbornly resisted their aid; he was playing a little game, seeing how well his ageing eyes would respond to the challenge. Though two astronomers on Mauna Kea already claimed to have observed the comet visually, no-one believed them, and similar assertions from other residents of Pasteur had been treated with even greater scepticism.

But tonight, a magnitude of at least six was predicted; he might be in luck. He traced the line from Gamma to Epsilon, and stared towards the apex of an imaginary equilateral triangle set upon it - almost as if he could focus his vision across the Solar System by a sheer effort of will.

And there it was! - just as he had first seen it, seventy-six years ago, inconspicuous but unmistakable. If he had not known exactly where to look, he would not even have noticed it, or would have dismissed it as some distant nebula.

To his naked eye it was merely a tiny, perfectly circular blob of mist; strain as he would, he was unable to detect any trace of a tail. But the small flotilla of probes that had been escorting the comet for months had already recorded the first outbursts of dust and gas that would soon create a glowing plume across the stars, pointing directly away from its creator, the Sun,

Like everyone else, Heywood Floyd had watched the transformation of the cold, dark - no, almost black - nucleus as it entered the inner Solar System. After seventy years of deepfreeze, the complex mixture of water, ammonia and other ices was beginning to thaw and bubble. A flying mountain, roughly the shape - and size - of the island of Manhattan was turning on a cosmic spit every fifty-three hours; as the heat of the Sun seeped through the insulating crust, the vaporizing gases were making Halley's Comet behave like a leaking steam-boiler. Jets of water vapour, mixed with dust and a witch's brew of organic chemicals, were bursting out from half a dozen small craters; the largest - about the size of a football field - erupted regularly about two hours after local dawn. It looked exactly like a terrestrial geyser, and had been promptly christened 'Old Faithful'.

Already, he had fantasies of standing on the rim of that crater, waiting for the Sun to rise above the dark, contorted landscape which he already knew well through the images from space. True, the contract said nothing about passengers - as opposed to crew and scientific personnel - going outside the ship when it landed on Halley.

On the other hand, there was also nothing in the small print that specifically forbade it.

They'll have a job to stop me, thought Heywood Floyd. I'm sure I can still handle a spacesuit. And if I'm wrong...

He remembered reading that a visitor to the Taj Mahal had once remarked: 'I'd die tomorrow for a monument like this.'

He would gladly settle for Halley's Comet.

3

Re-entry

Even apart from that embarrassing accident, the return to Earth had not been easy.

The first shock had come soon after revival, when Dr Rudenko had woken him from his long sleep. Walter Curnow was hovering beside her, and even in his semi-conscious state he could tell that something was wrong; their pleasure at seeing him awake was a little too exaggerated, and failed to conceal a sense of strain. Not until he was fully recovered did they let him know that Dr Chandra was no longer with them.

Somewhere beyond Mars, so imperceptibly that the monitors could not pinpoint the time, he had simply ceased to live. His body, set adrift in space, had continued unchecked along Leonov's orbit, and had long since been consumed by the fires of the Sun.

The cause of death was totally unknown, but Max Brailovsky expressed a view that, highly unscientific though it was, not even Surgeon-Commander Katerina Rudenko attempted to refute.

'He couldn't live without Hal.'

Walter Curnow, of all people, added another thought.

'I wonder how Hal will take it?' he asked. 'Something out there must be monitoring all our broadcasts. Sooner or later, he'll know.'

And now Curnow was gone too - so were they all except little Zenia. He had not seen her for twenty years, but her card arrived punctually every Christmas. The last one was still pinned above his desk; it showed a troika laden with gifts speeding through the snows of a Russian winter, watched by extremely hungry-looking wolves.

Forty-five years! Sometimes it seemed only yesterday that Leonov had returned to Earth orbit, and the applause of all mankind. Yet it had been a curiously subdued applause, respectful but lacking genuine enthusiasm. The mission to Jupiter had been altogether too much of a success; it had opened a Pandora's box, the full contents of which had yet to be disclosed.

When the black monolith known as Tycho Magnetic Anomaly One had been excavated on the Moon, only a handful of men knew of its existence. Not until after Discovery's ill-fated voyage to Jupiter did the world learn that, four million years ago, another intelligence had passed through the Solar System, and left its calling card. The news was a revelation - but not a surprise; something of the sort had been expected for decades.

And it had all happened long before the human race existed. Although some mysterious accident had befallen Discovery out round Jupiter, there was no real evidence that it involved anything more than a shipboard malfunction. Although the philosophical consequences of TMA 1 were profound, for all practical purposes mankind was still alone in the Universe.

Now that was no longer true. Only light minutes away - a mere stone's throw in the Cosmos - was an intelligence that could create a star, and, for its own inscrutable purpose, destroy a planet a thousand times the size of Earth. Even more ominous was the fact that it had shown awareness of mankind, through the last message that Discovery had beamed back from the moons of Jupiter just before the fiery birth of Lucifer had destroyed it:

ALL THESE WORLDS ARE YOURS - EXCEPT EUROPA.
ATTEMPT NO LANDINGS THERE.

The brilliant new star, which had banished night except for the few months in each year when it was passing behind the Sun, had brought both hope and fear to mankind. Fear - because the Unknown, especially when it appeared linked with omnipotence - could not fail to rouse such primeval emotions. Hope - because of the transformation it had wrought in global politics.

It had often been said that the only thing that could unite mankind was a threat from space. Whether Lucifer was a threat, no-one knew; but it was certainly a challenge. And that, as it turned out, was enough.

Heywood Floyd had watched the geopolitical changes from his vantage point on Pasteur, almost as if he was an alien observer himself. At first, he had no intention of remaining in space, once his recovery was complete. To the baffled annoyance of his doctors, that took an altogether unreasonable length of time.

Looking back from the tranquillity of later years, Floyd knew exactly why his bones refused to mend.

He simply did not wish to return to Earth: there was nothing for him, down on the dazzling blue and white globe that filled his sky. There were times when he could well understand how Chandra might have lost the will to live.

It was pure chance that he had not been with his first wife on that flight to Europe. Now Marion was part of another life, that might have belonged to someone else, and their two daughters were amiable strangers with families of their own.

But he had lost Caroline through his own actions, even though he had no real choice in the matter. She had never understood (had he really done so himself?) why he had left the beautiful home they had made together, to exile himself for years in the cold wastes far from the Sun.

Though he had known, even before the mission was half over, that Caroline would not wait, he had hoped desperately that Chris would forgive him. But even this consolation had been denied; his son had been without a father for too long. By the time that Floyd returned, he had found another, in the man who had taken his place in Caroline's life. The estrangement was complete; he thought he would never get over it, but of course he did - after a fashion.

His body had cunningly conspired with his unconscious desires. When at last he returned to Earth, after his protracted convalescence in Pasteur, he promptly developed such alarming symptoms - including something suspiciously like bone necrosis - that he was immediately rushed back to orbit. And there he had stayed, apart from a few excursions to the Moon, completely adapted to living in the zero to one-sixth gravity regime of the slowly rotating space hospital.

He was not a recluse - far from it. Even while he was convalescing, he was dictating reports, giving evidence to endless commissions, being interviewed by media representatives. He was a famous man, and enjoyed

the experience - while it lasted. It helped to compensate for his inner wounds.

The first complete decade - 2020 to 2030 - seemed to have passed so swiftly that he now found it difficult to focus upon it. There were the usual crises, scandals, crimes, catastrophes - notably the Great Californian Earthquake, whose aftermath he had watched with fascinated horror through the station's monitor screens. Under their greatest magnification, in favourable conditions, they could show individual human beings; but from his God's-eye-view it had been impossible to identify with the scurrying dots fleeing from the burning cities. Only the ground cameras revealed the true horror.

During that decade, though the results would not be apparent until later, the political tectonic plates were moving as inexorably as the geological ones - yet in the opposite sense, as if time was running backwards. For in the beginning, the Earth had possessed the single supercontinent of Pangaea, which over the aeons had split asunder. So had the human species, into innumerable tribes and nations; now it was merging together, as the old linguistic and cultural divisions began to blur.

Although Lucifer had accelerated the process, it had begun decades earlier, when the coming of the jet age had triggered an explosion of global tourism. At almost the same time - it was not, of course, a coincidence - satellites and fibre optics had revolutionized communications. With the historic abolition of long-distance charges on 31 December 2000, every telephone call became a local one, and the human race greeted the new millennium by transforming itself into one huge, gossiping family.

Like most families, it was not always a peaceful one, but its disputes no longer threatened the entire planet. The second - and last - nuclear war saw the use in combat of no more bombs than the first: precisely two. And though the kilotonnage was greater, the casualties were far fewer, as both were used against sparsely populated oil installations. At that point the Big

Three of China, the US and the USSR moved with commendable speed and wisdom, sealing off the battle zone until the surviving combatants had come to their senses.

By the decade of 2020-30, a major war between the Great Powers was as unthinkable as one between Canada and the United States had been in the century before. This was not due to any vast improvement in human nature, or indeed to any single factor except the normal preference of life over death. Much of the machinery of peace was not even consciously planned: before the politicians realized what had happened, they discovered that it was in place, and functioning well...

No statesman, no idealist of any persuasion invented the 'Peace Hostage' movement; the very name was not coined until well after someone had noticed that at any given moment there were a hundred thousand Russian tourists in the United States - and half a million Americans in the Soviet Union, most of them engaged in their traditional pastime of complaining about the plumbing. And perhaps even more to the point, both groups contained a disproportionately large number of highly non-expendable individuals - the sons and daughters of wealth, privilege and political power.

And even if one wished, it was no longer possible to plan a large-scale war. The Age of Transparency had dawned in the 1990s, when enterprising news media had started to launch photographic satellites with resolutions comparable to those that the military had possessed for three decades. The Pentagon and the Kremlin were furious; but they were no match for Reuters, Associated Press and the unsleeping, twenty-four-hours-a-day cameras of the Orbital News Service.

By 2060, even though the world had not been completely disarmed, it had been effectively pacified, and the fifty remaining nuclear weapons were all under international control. There was surprisingly little opposition when that popular monarch, Edward VIII, was elected the first Planetary President, only a dozen states dissenting. They ranged in size

and importance from the still stubbornly neutral Swiss (whose restaurants and hotels nevertheless greeted the new bureaucracy with open arms) to the even more fanatically independent Malvinians, who now resisted all attempts by the exasperated British and Argentines to foist them off on each other.

The dismantling of the vast and wholly parasitic armaments industry had given an unprecedented - sometimes, indeed, unhealthy - boost to the world economy. No longer were vital raw materials and brilliant engineering talents swallowed up in a virtual black hole - or, even worse, turned to destruction. Instead, they could be used to repair the ravages and neglect of centuries, by rebuilding the world.

And building new ones. Now indeed mankind had found the 'moral equivalent of war', and a challenge that could absorb the surplus energies of the race - for as many millennia ahead as anyone dared to dream.

4

Tycoon

When he was born, William Tsung had been called 'the most expensive baby in the world'; he held the title for only two years before it was claimed by his sister. She still held it, and now that the Family Laws had been repealed, it would never be challenged.

Their father, the legendary Sir Lawrence, had been born when China had re-instituted the stringent 'One Child, One Family' rule; his generation had provided psychologists and social scientists with material for endless studies. Having no brothers or sisters - and in many cases, no uncles or aunts - it was unique in human history. Whether credit was due to the resilience of the species or the merit of the Chinese 'extended family'

system would probably never be settled. The fact remained that the children of that strange time were remarkably free from scars; but they were certainly not unaffected, and Sir Lawrence had done his somewhat spectacular best to make up for the isolation of his infancy.

When his second child was born in '22, the licensing system had become law. You could have as many children as you wished, provided only that you paid the appropriate fee. (The surviving old guard communists were not the only ones who thought the whole scheme perfectly appalling, but they were outvoted by their pragmatic colleagues in the fledgling congress of the People's Democratic Republic.)

Numbers one and two were free. Number three cost a million sols. Number four was two million. Number five was four million, and so on. The fact that, in theory, there were no capitalists in the People's Republic was cheerfully ignored.

Young Mr Tsung (that was years, of course, before King Edward gave him his KBE) never revealed if he had any target in mind; he was still a fairly poor millionaire when his fifth child was born. But he was still only forty, and when the purchase of Hong Kong did not take quite as much of his capital as he had feared, he discovered that he had a considerable amount of small change in hand.

So ran the legend - but, like many other stories about Sir Lawrence, it was hard to distinguish fact from mythology. There was certainly no truth in the persistent rumour that he had made his first fortune through the famous shoe-box-sized pirate edition of the Library of Congress. The whole Molecular Memory Module racket was an off-Earth operation, made possible by the United States' failure to sign the Lunar Treaty.

Even though Sir Lawrence was not a multitrillionaire, the complex of corporations he had built up made him the greatest financial power on earth - no small achievement for the son of a humble videocassette peddler in what was still known as the New Territories. He probably never noticed

the eight million for Child Number Six, or even the thirty-two for Number Eight. The sixty-four he had to advance on Number Nine attracted world publicity, and after Number Ten the bets placed on his future plans may well have exceeded the two hundred and fifty-six million the next child would have cost him. However, at that point the Lady Jasmine, who combined the best properties of steel and silk in exquisite proportion, decided that the Tsung dynasty was adequately established.

It was quite by chance (if there is such a thing) that Sir Lawrence became personally involved in the space business. He had, of course, extensive maritime and aeronautical interests, but these were handled by his five sons and their associates. Sir Lawrence's real love was communications - newspapers (those few that were left), books, magazines (paper and electronic) and, above all, the global television networks.

Then he had bought the magnificent old Peninsular Hotel, which to a poor Chinese boy had once seemed the very symbol of wealth and power, and turned it into his residence and main office. He surrounded it by a beautiful park, by the simple expedient of pushing the huge shopping centres underground (his newly formed Laser Excavation Corporation made a fortune in the process, and set a precedent for many other cities).

One day, as he was admiring the unparalleled skyline of the city across the harbour, he decided that a further improvement was necessary. The view from the lower floors of the Peninsular had been blocked for decades by a large building looking like a squashed golfball. This, Sir Lawrence decided, would have to go.

The Director of the Hong Kong Planetarium - widely considered to be among the five best in the world - had other ideas, and very soon Sir Lawrence was delighted to discover someone he could not buy at any price. The two men became firm friends; but when Dr Hessenstein arranged a special presentation for Sir Lawrence's sixtieth birthday, he did not know that he would help to change the history of the Solar System.

More than a hundred years after Zeiss had built the first prototype in Jena in 1924, there were still a few optical planetarium projectors in use, looming dramatically over their audiences. But Hong Kong had retired its third-generation instrument decades ago, in favour of the far more versatile electronic system. The whole of the great dome was, essentially, a giant television screen, made up of thousands of separate panels, on which any conceivable image could be displayed.

The programme had opened - inevitably - with a tribute to the unknown inventor of the rocket, somewhere in China during the thirteenth century. The first five minutes were a high-speed historical survey, giving perhaps less than due credit to the Russian, German and American pioneers in order to concentrate on the career of Dr Hsue-Shen Tsien. His countrymen could be excused, in such a time and place, if they made him appear as important in the history of rocket development as Goddard, von Braun, or Korolev. And they certainly had just grounds for indignation at his arrest on trumped-up charges in the United States when, after helping to establish the famed Jet Propulsion Laboratory and being appointed Caltech's first Goddard Professor, he decided to return to his homeland.

The launching of the first Chinese satellite by the 'Long March 1' rocket in 1970 was barely mentioned, perhaps because at that time the Americans were already walking on the Moon. Indeed, the rest of the twentieth century was dismissed in a few minutes, to take the story up to 2007 and the construction of the spaceship Tsien.

The narrator did not gloat unduly over the consternation of the other spacefaring powers, when a presumed Chinese space station suddenly blasted out of orbit and headed for Jupiter, to overtake the Russian-American mission aboard the Cosmonaut Alexei Leonov. The story was dramatic - and tragic - enough to require no embellishment.

Unfortunately, there was very little authentic visual material to illustrate it: the programme had to rely largely on special effects and intelligent reconstruction from later, long-range photo-surveys. During their brief sojourn on the icy surface of Europa, Tsien's crew had been far too busy to make television documentaries, or even set up an unattended camera.

Nevertheless, the words spoken at the time conveyed much of the drama of that first landing on the moons of Jupiter. The commentary broadcast from the approaching Leonov by Heywood Floyd served admirably to set the scene, and there were plenty of library shots of Europa to illustrate it:

'At this very moment I'm looking at it through the most powerful of the ship's telescopes; under this magnification, it's ten times larger than the Moon as you see it with the naked eye. And it's a really weird sight.

'The surface is a uniform pink, with a few small brown patches. It's covered with an intricate network of narrow lines, curling and weaving in all directions. In fact, it looks very much like a photo from a medical textbook, showing a pattern of veins and arteries.

'A few of these features are hundreds - or even thousands - of kilometres long, and look rather like the illusory canals that Percival Lowell and other early-twentieth-century astronomers imagined they'd seen on Mars.

'But Europa's canals aren't an illusion, though of course they're not artificial. What's more, they do contain water - or at least ice. For the satellite is almost entirely covered by ocean, averaging fifty kilometres deep.

'Because it's so far from the Sun, Europa's surface temperature is extremely low - about a hundred and fifty degrees below freezing. So one might expect its single ocean to be a solid block of ice.

'Surprisingly, that isn't the case because there's a lot of heat generated inside Europa by tidal forces - the same forces that drive the great volcanoes on neighbouring Io.

'So the ice is continually melting, breaking up and freezing, forming cracks and lanes like those in the floating ice sheets in our own polar regions. It's that intricate tracery of cracks I'm seeing now; most of them are dark and very ancient - perhaps millions of years old. But a few are almost pure white; they're the new ones that have just opened up, and have a crust only a few centimetres thick.

'Tsien has landed right beside one of these white streaks - the fifteen-hundred-kilometre-long feature that's been christened the Grand Canal. Presumably the Chinese intend to pump its water into their propellant tanks, so that they can explore the Jovian satellite system and then return to Earth. That may not be easy, but they'll certainly have studied the landing site with great care, and must know what they're doing.

'It's obvious, now, why they've taken such a risk - and why they claim Europa. As a refuelling point, it could be the key to the entire Solar System...'

But it hadn't worked out that way, thought Sir Lawrence, as he reclined in his luxurious chair beneath the streaked and mottled disc that filled his artificial sky. The oceans of Europa were still inaccessible to mankind, for reasons which were still a mystery. And not only inaccessible, but invisible: since Jupiter had become a sun, both its inner satellites had vanished beneath clouds of vapour boiling out from their interiors. He was looking at Europa as it had been back in 2010 - not as it was today.

He had been little more than a boy then, but could still remember the pride he felt in knowing that his countrymen - however much he disapproved of their politics - were about to make the first landing on a virgin world.

There had been no camera there, of course, to record that landing, but the reconstruction was superbly done. He could really believe that was the doomed spaceship dropping silently out of the jetblack sky towards the European icescape, and coming to rest beside the discoloured band of recently frozen water that had been christened the Grand Canal.

Everyone knew what had happened next; perhaps wisely, there had been no attempt to reproduce it visually. Instead, the image of Europa faded, to be replaced by a portrait as familiar to every Chinese as Yuri Gagarin's was to every Russian.

The first photograph showed Rupert Chang on his graduation day in 1989 - the earnest young scholar, indistinguishable from a million others, utterly unaware of his appointment with history two decades in the future.

Briefly, to a background of subdued music, the commentator summed up the highlights of Dr Chang's career, until his appointment as Science Officer aboard Tsien. Cross-sections in time, the photographs grew older, until the last one, taken immediately before the mission.

Sir Lawrence was glad of the planetarium's darkness; both his friends and his enemies would have been surprised to see the moisture gathering in his eyes as he listened to the message that Dr Chang had aimed towards the approaching Leonov, never knowing if it would be received.

'... know you are aboard Leonov... may not have much time... aiming my suit antenna where I think...'

The signal vanished for agonizing seconds, then came back much clearer, though not appreciably louder.

'... relay this information to Earth. Tsien destroyed three hours ago. I'm only survivor. Using my suit radio - no idea if it has enough range, but it's the only chance. Please listen carefully. THERE IS LIFE ON EUROPA. I repeat: THERE IS LIFE ON EUROPA...

The signal faded again.

'... soon after local midnight. We were pumping steadily and the tanks were almost half full. Dr Lee and I went out to check the pipe insulation. Tsien stands - stood - about thirty metres from the edge of the Grand Canal. Pipes go directly from it and down through the ice. Very thin - not safe to walk on. The warm upwelling...'

Again a long silence.

'... no problem - five kilowatts of lighting strung up on the ship. Like a Christmas tree - beautiful, shining right through the ice. Glorious colours. Lee saw it first - a huge dark mass rising up from the depths. At first we thought it was a school of fish - too large for a single organism - then it started to break through the ice.

'... like huge strands of wet seaweed, crawling along the ground. Lee ran back to the ship to get a camera - I stayed to watch, reporting over the radio. The thing moved so slowly I could easily outrun it. I was much more excited than alarmed. Thought I knew what kind of creature it was - I've seen pictures of the kelp forests off California - but I was quite wrong...

I could tell it was in trouble. It couldn't possibly survive at a temperature a hundred and fifty below its normal environment. It was freezing solid as it moved forward - bits were breaking off like glass - but it was still advancing towards the ship - a black tidal wave, slowing down all the time.

'I was still so surprised that I couldn't think straight and I couldn't imagine what it was trying to do.

'... climbing up the ship, building a kind of ice tunnel as it advanced. Perhaps this was insulating it from the cold - the way termites protect themselves from Sunlight with their little corridors of mud.

'... tons of ice on the ship. The radio antennas broke off first. Then I could see the landing legs beginning to buckle - all in slow motion, like a dream.

'Not until the ship started to topple did I realize what the thing was trying to do - and then it was too late. We could have saved ourselves - if we'd only switched off those lights.

'Perhaps it's a phototrope, its biological cycle triggered by the Sunlight that filters through the ice. Or it could have been attracted like a moth to a candle. Our floodlights must have been more brilliant than anything that Europa has ever known.

'Then the ship crashed. I saw the hull split, a cloud of snowflakes form as moisture condensed. All the lights went out, except for one, swinging back and forth on a cable a couple of metres above the ground.

'I don't know what happened immediately after that. The next thing I remember, I was standing under the light, beside the wreck of the ship, with a fine powdering of fresh snow all around me. I could see my footsteps in it very clearly... I must have run there; perhaps only a minute or two had elapsed...

'The plant - I still thought of it as a plant - was motionless. I wondered if it had been damaged by the impact; large sections - as thick as a man's arm - had splintered off, like broken twigs.

'Then the main trunk started to move again. It pulled away from the hull, and began to crawl towards me. That was when I knew for certain that the thing was light-sensitive: I was standing immediately under the thousand-watt lamp, which had stopped swinging now.

'Imagine an oak tree - better still, a banyan with its multiple trunks and roots - flattened out by gravity and trying to creep along the ground. It got to within five metres of the light, then started to spread out until it had made a perfect circle around me. Presumably that was the limit of its tolerance -the point at which photo-attraction turned to repulsion. After that, nothing happened for several minutes. I wondered if it was dead - frozen solid at last.

'Then I saw that large buds were forming on many of the branches. It was like watching a time-lapse film of flowers opening. In fact I thought they were flowers - each about as big as a man's head.

'Delicate, beautifully coloured membranes started to unfold. Even then, it occurred to me that no-one - no thing - could ever have seen these colours before; they had no existence until we brought our lights - our fatal lights - to this world.

'Tendrils, stamens, waving feebly... I walked over to the living wall that surrounded me, so that I would see exactly what was happening. Neither then, or at any other time, had I felt the slightest fear of the creature. I was certain that it was not malevolent - if indeed it was conscious at all.

'There were scores of the big flowers, in various stages of unfolding. Now, they reminded me of butterflies, just emerging from the chrysalis... wings crumpled, still feeble... I was getting closer and closer to the truth.

'But they were freezing - dying as quickly as they formed. Then, one after another, they dropped off from the parent buds. For a few moments they flopped around like fish stranded on dry land - and at last I realized exactly what they were. Those membranes weren't petals - they were fins,

or their equivalent. This was the free-swimming, larval stage of the creature. Probably it spends much of its life rooted on the seabed, then sends these mobile offspring in search of new territory. Just like the corals of Earth's oceans.

I knelt down to get a closer look at one of the little creatures. The beautiful colours were fading now, to a drab brown. Some of the petal-fins had snapped off, becoming brittle shards as they froze. But it was still moving feebly, and as I approached it tried to avoid me. I wondered how it sensed my presence.

'Then I noticed that the stamens - as I'd called them - all carried bright blue dots at their tips. They looked like tiny star sapphires - or the blue eyes along the mantle of a scallop - aware of light, but unable to form true images. As I watched, the vivid blue faded, the sapphires became dull, ordinary stones...

'Dr Floyd - or anyone else who is listening - I haven't much more time - Jupiter will soon block my signal. But I've almost finished.

I knew then what I had to do. The cable to that thousand-watt lamp was hanging almost to the ground. I gave it a few tugs, and the light went out in a shower of sparks.

I wondered if it was too late. For a few minutes, nothing happened. So I walked over to the wall of tangled branches around me, and kicked it.

'Slowly, the creature started to unweave itself, and to retreat back to the Canal. There was plenty of light - I could see everything perfectly. Ganymede and Callisto were in the sky - Jupiter was a huge, thin crescent - and there was a big auroral display on the nightside, at the Jovian end of the Io flux tube. There was no need to use my helmet light.

I followed the creature all the way back to the water, encouraging it with more kicks when it slowed down, feeling the fragments of ice

crunching all the time beneath my boots... As it neared the Canal, it seemed to gain strength and energy, as if it knew that it was approaching its natural home. I wondered if it would survive, to bud again.

'It disappeared through the surface, leaving a few last dead larvae on the alien land. The exposed free water bubbled for a few minutes until a scab of protective ice sealed it from the vacuum above. Then I walked back to the ship to see if there was anything to salvage - I don't want to talk about that...

'I've only two requests to make, Doctor. When the taxonomists classify this creature, I hope they'll name it after me.

'And - when the next ship comes home - ask them to take our bones back to China..

'Jupiter will be cutting us off in a few minutes. I wish I knew whether anyone was receiving me. Anyway, I'll repeat this message when we're in line of sight again - if my suit's life-support system lasts that long.

'This is Professor Chang on Europa, reporting the destruction of spaceship Tsien. We landed beside the Grand Canal and set up our pumps at the edge of the ice...'

The signal faded abruptly, came back for a moment, then disappeared completely below the noise level. There would never be any further message from Professor Chang; but it had already deflected Lawrence Tsung's ambitions into space.

The Greening of Ganymede

Rolf van der Berg was the right man, in the right place, at the right time; no other combination would have worked. Which, of course, is how much of history is made.

He was the right man because he was a second-generation Afrikaner refugee, and a trained geologist; both factors were equally important. He was in the right place, because that had to be the largest of the Jovian moons - third outwards in the sequence Io, Europa, Ganymede, Callisto.

The time was not so critical, for the information had been ticking away like a delayed-action bomb in the data banks for at least a decade. Van der Berg did not encounter it until '57; even then it took him another year to convince himself that he was not crazy - and it was '59 before he had quietly sequestered the original records so that no-one could duplicate his discovery. Only then could he safely give his full attention to the main problem: what to do next.

It had all begun, as is so often the case, with an apparently trivial observation in a field which did not even concern van der Berg directly. His job, as a member of the Planetary Engineering Task Force, was to survey and catalogue the natural resources of Ganymede; he had little business fooling around with the forbidden satellite next door.

But Europa was an enigma which no-one - least of all its immediate neighbours - could ignore for long. Every seven days it passed between Ganymede and the brilliant minisun that had once been Jupiter, producing eclipses which could last as long as twelve minutes. At its closest, it appeared slightly smaller than the Moon as seen from Earth, but it

dwindled to a mere quarter of that size when it was on the other side of its orbit.

The eclipses were often spectacular. Just before it slid between Ganymede and Lucifer, Europa would become an ominous black disc, outlined with a ring of crimson fire, as the light of the new sun was refracted through the atmosphere it had helped to create.

In less than half a human lifetime, Europa had been transformed. The crust of ice on the hemisphere always facing Lucifer had melted, to form the Solar System's second ocean. For a decade it had foamed and bubbled into the vacuum above it, until equilibrium had been reached. Now Europa possessed a thin but serviceable - though not to human beings - atmosphere of water vapour, hydrogen sulphide, carbon and sulphur dioxides, nitrogen, and miscellaneous rare gases. Though the somewhat misnamed 'nightside' of the satellite was still permanently frozen, an area as large as Africa now had a temperate climate, liquid water, and a few scattered islands.

All this, and not much more, had been observed through telescopes in Earth orbit. By the time that the first full-scale expedition had been launched to the Galilean moons, in 2028, Europa had already become veiled by a permanent mantle of clouds. Cautious radar probing revealed little but smooth ocean on one face, and almost equally smooth ice on the other; Europa still maintained its reputation as the flattest piece of real estate in the Solar System. Ten years later, that was no longer true: something drastic had happened to Europa. It now possessed a solitary mountain, almost as high as Everest, jutting up through the ice of the twilight zone. Presumably some volcanic activity - like that occurring ceaselessly on neighbouring Io - had thrust this mass of material skywards. The vastly increased heat-flow from Lucifer could have triggered such an event.

But there were problems with this obvious explanation. Mount Zeus was an irregular pyramid, not the usual volcanic cone, and radar scans

showed none of the characteristic lava flows. Some poor-quality photographs obtained through telescopes on Ganymede, during a momentary break in the clouds, suggested that it was made of ice, like the frozen landscape around it. Whatever the answer, the creation of Mount Zeus had been a traumatic experience for the world it dominated, for the entire crazy-paving pattern of fractured ice floes over the nightside had changed completely.

One maverick scientist had put forward the theory that Mount Zeus was a 'cosmic iceberg' - a cometary fragment that had dropped upon Europa from space; battered Callisto gave ample proof that such bombardments had occurred in the remote past. The theory was very unpopular on Ganymede, whose would-be colonists already had sufficient problems.

They had been much relieved when van der Berg had refuted the theory convincingly; any mass of ice this size would have shattered on impact - and even if it hadn't, Europa's gravity, modest though it was, would have quickly brought about its collapse. Radar measurements showed that though Mount Zeus was indeed steadily sinking, its overall shape remained completely unaltered. Ice was not the answer.

The problem could, of course, have been settled by sending a single probe through the clouds of Europa. Unfortunately, whatever was beneath that almost permanent overcast did not encourage curiosity.

**ALL THESE WORLDS ARE YOURS - EXCEPT EUROPA.
ATTEMPT NO LANDINGS THERE.**

That last message relayed from the spaceship Discovery just before its destruction had not been forgotten, but there had been endless arguments about its interpretation. Did 'landings' refer to robot probes, or only to

manned vehicles? And what about close flybys - manned or unmanned? Or balloons floating in the upper atmosphere?

The scientists were anxious to find out, but the general public was distinctly nervous. Any power that could detonate the mightiest planet in the Solar System was not to be trifled with. And it would take centuries to explore and exploit Io, Ganymede, Callisto and the dozens of minor satellites; Europa could wait.

More than once, therefore, van der Berg had been told not to waste his valuable time on research of no practical importance, when there was so much to be done on Ganymede. ('Where can we find carbon - phosphorus - nitrates for the hydroponic farms? How stable is the Barnard Escarpment? Is there any danger of more mudslides in Phrygia?' And so on and so forth...) But he had inherited his Boer ancestors' well-deserved reputation for stubbornness: even when he was working on his numerous other projects, he kept looking over his shoulder at Europa.

And one day, just a few hours, a gale from the night side cleared the skies about Mount Zeus.

7

Transit

'I too take leave of all I ever had...'

From what depths of memory had that line come swimming up to the surface? Heywood Floyd closed his eyes, and tried to focus on the past. It was certainly from a poem - and he had hardly read a line of poetry since leaving college. And little enough then, except during a short English Appreciation Seminar.

With no further clues, it might take the station computer quite a while - perhaps as much as ten minutes - to locate the line in the whole body of English literature. But that would be cheating (not to mention expensive) and Floyd preferred to accept the intellectual challenge.

A war poem, of course - but which war? There had been so many in the twentieth century.

He was still searching through the mental mists when his guests arrived, moving with the effortless, slow-motion grace of longtime one-sixth gravity residents. The society of Pasteur was strongly influenced by what had been christened 'centrifugal stratification'; some people never left the zero gee of the hub, while those who hoped one day to return to Earth preferred the almost normal-weight regime out on the rim of the huge, slowly revolving disc.

George and Jerry were now Floyd's oldest and closest friends - which was surprising, because they had so few obvious points in common. Looking back on his own somewhat chequered emotional career - two marriages, three formal contracts, two informal ones, three children - he often envied the long-term stability of their relationship, apparently quite unaffected by the 'nephews' from Earth or Moon who visited them from time to time.

'Haven't you ever thought of divorce?' he had once asked them teasingly.

As usual, George - whose acrobatic yet profoundly serious conducting had been largely responsible for the comeback of the classical orchestra - was at no loss for words.

'Divorce - never,' was his swift reply. 'Murder - often.'

'Of course, he'd never get away with it,' Jerry had retorted. 'Sebastian would spill the beans.'

Sebastian was a beautiful and talkative parrot which the couple had imported after a long battle with the hospital authorities. He could not only talk, but could reproduce the opening bars of the Sibelius Violin Concerto, with which Jerry - considerably helped by Antonio Stradivari - had made his reputation half a century ago.

Now the time had come to say goodbye to George, Jerry and Sebastian - perhaps only for a few weeks, perhaps for ever. Floyd had already made all his other farewells, in a round of parties that had gravely depleted the station's wine cellar, and could think of nothing he had left undone.

Archie, his early-model but still perfectly serviceable comsec, had been programmed to handle all incoming messages, either by sending out appropriate replies or by routing anything urgent and personal to him aboard Universe. It would be strange, after all these years, not to be able to talk to anyone he wished - though in compensation he could also avoid unwanted callers. After a few days into the voyage, the ship would be far enough from Earth to make real-time conversation impossible, and all communication would have to be by recorded voice or teletext.

'We thought you were our friend,' complained George. 'It was a dirty trick to make us your executors - especially as you're not going to leave us anything.'

'You may have a few surprises,' grinned Floyd. 'Anyway, Archie will take care of all the details. I'd just like you to monitor my mail, in case there's anything he doesn't understand.'

'If he won't, nor will we. What do we know about all your scientific societies and that sort of nonsense?'

'They can look after themselves. Please see that the cleaning staff doesn't mess things up too badly while I'm away - and, if I don't come back - here are a few personal items I'd like delivered - mostly family.'

Family! There were pains, as well as pleasures, in living as long as he had done.

It had been sixty-three - sixty-three! - years since Marion had died in that air crash. Now he felt a twinge of guilt, because he could not even recall the grief he must have known. Or at best, it was a synthetic reconstruction, not a genuine memory.

What would they have meant to each other, had she still been alive? She would have been just a hundred years old by now.

And now the two little girls he had once loved so much were friendly, grey-haired strangers in their late sixties, with children - and grandchildren! - of their own. At last count there had been nine on that side of the family; without Archie's help, he would never be able to keep track of their names. But at least they all remembered him at Christmas, through duty if not affection.

His second marriage, of course, had overlain the memories of his first, like the later writing on a medieval palimpsest. That too had ended, fifty years ago, somewhere between Earth and Jupiter. Though he had hoped for a reconciliation with both wife and son, there had been time for only one brief meeting, among all the welcoming ceremonies, before his accident exiled him to Pasteur.

The meeting had not been a success; nor had the second, arranged at considerable expense and difficulty aboard the space hospital itself - indeed, in this very room. Chris had been twenty then, and had just married; if there was one thing that united Floyd and Caroline, it was disapproval of his choice.

Yet Helena had turned out remarkably well: she had been a good mother to Chris II, born barely a month after the marriage. And when, like so many other young wives, she was widowed by the Copernicus Disaster, she did not lose her head.

There was a curious irony in the fact that both Chris I and II had lost their fathers to space, though in very different ways. Floyd had returned briefly to his eight-year-old son as a total stranger; Chris II had at least known a father for the first decade of his life, before losing him for ever.

And where was Chris these days? Neither Caroline nor Helena - who were now the best of friends - seemed to know whether he was on Earth or in space. But that was typical; only postcards date-stamped CLAVIUS BASE had informed his family of his first visit to the Moon.

Floyd's card was still taped prominently above his desk. Chris II had a good sense of humour - and of history. He had mailed his grandfather that famous photograph of the Monolith, looming over the spacesuited figures gathered round it in the Tycho excavation, more than half a century ago. All the others in the group were now dead, and the Monolith itself was no longer on the Moon. In 2006, after much controversy, it had been brought to Earth and erected - an uncanny echo of the main building - in the United Nations Plaza. It had been intended to remind the human race that it was no longer alone; five years later, with Lucifer blazing in the sky, no such reminder was needed.

Floyd's fingers were not very steady - sometimes his right hand seemed to have a will of its own - as he unpeeled the card and slipped it into his pocket. It would be almost the only personal possession he would take when he boarded Universe.

'Twenty-five days - you'll be back before we've noticed you're gone,' said Jerry. 'And by the way, is it true that you'll have Dimitri onboard?'

'That little Cossack!' snorted George. 'I conducted his Second Symphony, back in '22.'

'Wasn't that when the First Violin threw up, during the largo?'

'No - that was Mahler, not Mihailovich. And anyway it was the brass, so nobody noticed - except the unlucky tuba player, who sold his instrument the next day.'

'You're making this up!'

'Of course. But give the old rascal my love, and ask him if he remembers that night we had out in Vienna. Who else have you got aboard?'

'I've heard horrible rumours about press gangs,' said Jerry thoughtfully.

'Greatly exaggerated, I can assure you. We've all been personally chosen by Sir Lawrence for our intelligence, wit, beauty, charisma, or other redeeming virtue.'

'Not expendability?'

'Well, now that you mention it, we've all had to sign a depressing legal document, absolving Tsung Spacelines from every conceivable liability. My copy's in that file, by the way.'

'Any chance of us collecting on it?' asked George hopefully.

'No - my lawyers say it's iron-clad. Tsung agrees to take me to Halley and back, give me food, water, air, and a room with a view.'

'And in return?'

'When I get back I'll do my best to promote future voyages, make some video appearances, write a few articles - all very reasonable, for the chance of a lifetime. Oh yes - I'll also entertain my fellow passengers - and vice versa.'

'How? Song and dance?'

'Well, I hope to inflict selected portions of my memoirs on a captive audience. But I don't think I'll be able to compete with the professionals. Did you know that Yva Merlin will be on board?'

'What! How did they coax her out of that Park Avenue cell?'

'She must be a hundred and - oops, sorry, Hey.' 'She's seventy, plus or minus five.'

'Forget the minus. I was just a kid when Napoleon came out.'

There was a long pause while each of the trio scanned his memories of that famous work. Although some critics considered her Scarlett O'Hara to be her finest role, to the general public Yva Merlin (née Evelyn Miles, when she was born in Cardiff, South Wales) was still identified with Josephine. Almost half a century ago, David Griffin's controversial epic had delighted the French and infuriated the British - though both sides now agreed that he had occasionally allowed his artistic impulses to trifle with the historical record, notably in the spectacular final sequence of the Emperor's coronation in Westminster Abbey.

'That's quite a scoop for Sir Lawrence,' said George thoughtfully.

'I think I can claim some credit for that. Her father was an astronomer - he worked for me at one time - and she's always been quite interested in science. So I made a few video calls.'

Heywood Floyd did not feel it necessary to add that, like a substantial fraction of the human race, he had fallen in love with Yva ever since the appearance of GWTW Mark II.

'Of course,' he continued, 'Sir Lawrence was delighted - but I had to convince him that she had more than a casual interest in astronomy. Otherwise the voyage could be a social disaster.'

'Which reminds me,' said George, producing a small package he had been not very successfully hiding behind his back. 'We have a little present for you.'

'Can I open it now?'

'Do you think he should?' Jerry wondered anxiously.

'In that case, I certainly will,' said Floyd, untying the bright green ribbon and unwrapping the paper.

Inside was a nicely framed painting. Although Floyd knew little of art, he had seen it before; indeed, who could ever forget it?

The makeshift raft tossing on the waves was crowded with half-naked castaways, some already moribund, others waving desperately at a ship on the horizon. Beneath it was the caption:

THE RAFT OF THE MEDUSA
(Theodore Géricault, 1791-1824)

And underneath that was the message, signed by George and Jerry:
'Getting there is half the fun.'

'You're a pair of bastards, and I love you dearly,' said Floyd, embracing them both. The ATTENTION light on Archie's keyboard was flashing briskly; it was time to go.

His friends left in a silence more eloquent than words. For the last time, Heywood Floyd looked around the little room that had been his universe for almost half his life.

And suddenly he remembered how that poem ended:

'I have been happy: happy now I go.'

8

Starfleet

Sir Lawrence Tsung was not a sentimental man, and was far too cosmopolitan to take patriotism seriously - though as an undergraduate he had briefly sported one of the artificial pigtails worn during the Third Cultural Revolution. Yet the planetarium re-enactment of the Tsien disaster moved him deeply, and caused him to focus much of his enormous influence and energy upon space.

Before long, he was taking weekend trips to the Moon, and had appointed his son Charles (the thirty-two-million-so! one) as Vice-President of Tsung Astrofreight. The new corporation had only two catapult-launched, hydrogen-fuelled ramrockets of less than a thousand tons empty mass; they would soon be obsolete, but they could provide Charles with the experience that, Sir Lawrence was quite certain, would be

needed in the decades ahead. For at long last, the Space Age was truly about to begin.

Little more than half a century had separated the Wright Brothers and the coming of cheap, mass air transportation; it had taken twice as long to meet the far greater challenge of the Solar System.

Yet when Luis Alvarez and his team had discovered muon-catalysed fusion back in the 1950s, it had seemed no more than a tantalizing laboratory curiosity, of only theoretical interest. Just as the great Lord Rutherford had pooh-pooed the prospects of atomic power, so Alvarez himself doubted that 'cold nuclear fusion' would ever be of practical importance. Indeed, it was not until 2040 that the unexpected and accidental manufacture of stable muonium-hydrogen 'compounds' had opened up a new chapter of human history - exactly as the discovery of the neutron had initiated the Atomic Age.

Now small, portable nuclear power plants could be built, with a minimum of shielding. Such enormous investments had already been made in conventional fusion that the world's electrical utilities were not - at first - affected, but the impact on space travel was immediate; it could be paralleled only by the jet revolution in air transport of a hundred years earlier.

No longer energy-limited, spacecraft could achieve far greater speeds; flight times in the Solar System could now be measured in weeks rather than months or even years. But the muon drive was still a reaction device - a sophisticated rocket, no different in principle from its chemically fuelled ancestors; it needed a working fluid to give it thrust. And the cheapest, cleanest, and most convenient of all working fluids was - plain water.

The Pacific Spaceport was not likely to run short of this useful substance. Matters were different at the next port of call - the Moon. Not a trace of water had been discovered by the Surveyor, Apollo, and Luna

missions. If the Moon had ever possessed any native water, aeons of meteoric bombardment had boiled and blasted it into space.

Or so the selenologists believed; yet clues to the contrary had been visible, ever since Galileo had turned his first telescope upon the Moon. Some lunar mountains, for a few hours after dawn, glitter as brilliantly as if they are capped with snow. The most famous case is the rim of the magnificent crater Aristarchus, which William Herschel, the father of modern astronomy, once observed shining so brightly in the lunar night that he decided it must be an active volcano. He was wrong; what he saw was the Earthlight reflected from a thin and transient layer of frost, condensed during the three hundred hours of freezing darkness.

The discovery of the great ice deposits beneath Schroter's Valley, the sinuous canyon winding away from Anstarchus, was the last factor in the equation that would transform the economics of space-flight. The Moon could provide a filling station just where it was needed, high up on the outermost slopes of the Earth's gravitational field, at the beginning of the long haul to the planets.

Cosmos, first of the Tsung fleet, had been designed to carry freight and passengers on the Earth-Moon-Mars run, and as a test-vehicle, through complex deals with a dozen organizations and governments, of the still experimental muon drive. Built at the Imbriurn shipyards, she had just sufficient thrust to lift off from the Moon with zero payload; operating from orbit to orbit, she would never again touch the surface of any world. With his usual flair for publicity, Sir Lawrence arranged for her maiden flight to commence on the hundredth anniversary of Sputnik Day, 4 October 2057.

Two years later, Cosmos was joined by a sister ship. Galaxy was designed for the Earth-Jupiter run, and had enough thrust to operate directly to any of the Jovian moons, though at considerable sacrifice of payload. If necessary, she could even return to her lunar berth for refitting. She was by far the swiftest vehicle ever built by man: if she burned up her

entire propellant mass in one orgasm of acceleration, she would attain a speed of a thousand kilometres a second - which would take her from Earth to Jupiter in a week, and to the nearest star in not much more than ten thousand years.

The third ship of the fleet - and Sir Lawrence's pride and joy - embodied all that had been learned in the building of her two sisters. But Universe was not intended primarily for freight. She was designed from the beginning as the first passenger liner to cruise the space lanes - right out to Saturn, the jewel of the Solar System.

Sir Lawrence had planned something even more spectacular for her maiden voyage, but construction delays caused by a dispute with the Lunar Chapter of the Reformed Teamsters' Union had upset his schedule. There would just be time for the initial flight tests and Lloyd's certification in the closing months of 2060, before Universe left Earth orbit for her rendezvous. It would be a very close thing: Halley's Comet would not wait, even for Sir Lawrence Tsung.

9

Mount Zeus

The survey satellite Europa VI had been in orbit for almost fifteen years, and had far exceeded its design life; whether it should be replaced was a subject of considerable debate in the small Ganymede scientific establishment.

It carried the usual collection of data-gathering instruments, as well as a now virtually useless imaging system. Though still in perfect working order, all that this normally showed of Europa was an unbroken cloudscape. The overworked science team on Ganymede scanned the

recordings in 'Quick Look' mode once a week, then squirted the raw data back to Earth. On the whole, they would be rather relieved when Europa VI expired and its torrent of uninteresting gigabytes finally dried up.

Now, for the first time in years, it had produced something exciting.

'Orbit 71934,' said the Deputy Chief Astronomer, who had called van der Berg as soon as the latest data-dump had been evaluated. 'Coming in from the nightside - heading straight for Mount Zeus. You won't see anything for another ten seconds, though.'

The screen was completely black, yet van der Berg could imagine the frozen landscape rolling past beneath its blanket of clouds a thousand kilometres below. In a few hours the distant Sun would be shining there, for Europa revolved on its axis once in every seven Earth-days. 'Nightside' should really be called 'Twilight-side', for half the time it had ample light - but no heat. Yet the inaccurate name had stuck, because it had emotional validity: Europa knew Sunrise, but never Lucifer-rise.

And the Sunrise was coming now, speeded up a thousandfold by the racing probe. A faintly luminous band bisected the screen, as the horizon emerged from darkness.

The explosion of light was so sudden that van der Berg could almost imagine he was looking into the glare of an atomic bomb. In a fraction of a second, it ran through all the colours of the rainbow, then became pure white as the Sun leapt above the mountain - then vanished as the automatic filters cut into the circuit.

'That's all; pity there was no operator on duty at the time - he could have panned the camera down and had a good view of the mountain as we went over. But I knew you'd like to see it - even though it disproves your theory.'

'How?' said van der Berg, more puzzled than annoyed.

'When you go through it in slow motion, you'll see what I mean. Those beautiful rainbow effects - they're not atmospheric - they're caused by the mountain itself. Only ice could do that. Or glass - which doesn't seem very likely.'

'Not impossible - volcanoes can produce natural glass - but it's usually black... of course!'

'Yes?'

'Er - I won't commit myself until I've been through the data. But my guess would be rock crystal - transparent quartz. You can make beautiful prisms and lenses out of it. Any chance of some more observations?'

'I'm afraid not - that was pure luck - Sun, mountain, camera all lined up at the right time. It won't happen again in a thousand years.'

'Thanks, anyway - can you send me over a copy? No hurry - I'm just leaving on a field trip to Perrine, and won't be able to look at it until I get back.'

Van der Berg gave a short, rather apologetic laugh.

'You know, if that really is rock crystal, it would be worth a fortune. Might even help solve our balance of payments problem...'

But that, of course, was utter fantasy. Whatever wonders - or treasures - Europa might conceal, the human race had been forbidden access to them, by that last message from Discovery. Fifty years later, there was no sign that the interdiction would ever be lifted.

For the first forty-eight hours of the voyage, Heywood Floyd could not really believe the comfort, the spaciousness - the sheer extravagance of Universe's living arrangements. Yet most of his fellow passengers took them for granted; those who had never left Earth before assumed that all spaceships must be like this.

He had to look back at the history of aeronautics to put matters in the right perspective. In his own lifetime, he had witnessed - indeed, experienced - the revolution that had occurred in the skies of the planet now dwindling behind him. Between the clumsy old Leonov and the sophisticated Universe lay exactly fifty years. (Emotionally, he couldn't really believe that - but it was useless arguing about arithmetic.)

And just fifty years had separated the Wright Brothers from the first jet airliners. At the beginning of that half-century, intrepid aviators had hopped from field to field, begoggled and windswept on open chairs; at its end, grandmothers had slumbered peacefully between continents at a thousand kilometres an hour.

So he should not, perhaps, have been astonished at the luxury and elegant decor of his stateroom, or even the fact that he had a steward to keep it tidy. The generously sized window was the most startling feature of his suite, and at first he felt quite uncomfortable thinking of the tons of air pressure it was holding in check against the implacable, and never for a moment relaxing, vacuum of space.

The biggest surprise, even though the advance literature should have prepared him for it, was the presence of gravity. Universe was the first

spaceship ever built to cruise under continuous acceleration, except for the few hours of the mid-course 'turnaround'. When her huge propellant tanks were fully loaded with their five thousand tons of water, she could manage a tenth of a gee - not much, but enough to keep loose objects from drifting around. This was particularly convenient at mealtimes - though it took a few days for the passengers to learn not to stir their soup too vigorously.

Forty-eight hours out from Earth, the population of Universe had already stratified itself into four distinct classes.

The aristocracy consisted of Captain Smith and his officers. Next came the passengers; then crew - non-commissioned and stewards. And then steerage...

That was the description that the five young space scientists had adopted for themselves, first as a joke but later with a certain amount of bitterness. When Hoyd compared their cramped and jury-rigged quarters with his own luxurious cabin, he could see their point of view, and soon became the conduit of their complaints to the Captain.

Yet all things considered, they had little to grumble about; in the rush to get the ship ready, it had been touch and go as to whether there would be any accommodation for them and their equipment. Now they could look forward to deploying instruments around - and on - the comet during the critical days before it rounded the Sun, and departed once more to the outer reaches of the Solar System. The members of the science team would establish their reputations on this voyage, and knew it. Only in moments of exhaustion, or fury with misbehaving instrumentation, did they start complaining about the noisy ventilating system, the claustrophobic cabins, and occasional strange smells of unknown origin.

But never the food, which everyone agreed was excellent. 'Much better,' Captain Smith assured them, 'than Darwin had on the Beagle.'

To which Victor Willis had promptly retorted:

'How does he know? And by the way, Beagle's commander cut his throat when he got back to England.'

That was rather typical of Victor, perhaps the planet's best-known science communicator - to his fans - or 'pop-scientist' - to his equally numerous detractors. It would be unfair to call them enemies; admiration for his talents was universal, if occasionally grudging. His soft, mid-Pacific accent and expansive gestures on camera were widely parodied, and he had been credited (or blamed) for the revival of full-length beards. 'A man who grows that much hair,' critics were fond of saying, 'must have a lot to hide.'

He was certainly the most instantly recognizable of the six VIPs - though Floyd, who no longer regarded himself as a celebrity, always referred to them ironically as 'The Famous Five'. Yva Merlin could often walk unrecognized on Park Avenue, on the rare occasions when she emerged from her apartment. Dimitri Mihailovich, to his considerable annoyance, was a good ten centimetres below average height; this might help to explain his fondness for thousand-piece orchestras - real or synthesized -but did not enhance his public image.

Clifford Greenburg and Margaret M'Bala also fell into the category of 'famous unknowns' - though this would certainly change when they got back to Earth. The first man to land on Mercury had one of those pleasant, unremarkable faces that are very hard to remember; moreover the days when he had dominated the news were now thirty years in the past. And like most authors who are not addicted to talk shows and autographing sessions, Ms M'Bala would be unrecognized by the vast majority of her millions of readers.

Her literary fame had been one of the sensations of the forties. A scholarly study of the Greek pantheon was not usually a candidate for the best-seller lists, but Ms M'Bala had placed its eternally inexhaustible myths in a contemporary space-age setting. Names which a century earlier

had been familiar only to astronomers and classical scholars were now part of every educated person's world picture; almost every day there would be news from Ganymede, Callisto, Io, Titan, Japetus - or even more obscure worlds like Carme, Pasiphaë, Hyperion, Phoebe...

Her book would have been no more than modestly successful, however, had she not focused on the complicated family life of Jupiter-Zeus, Father of all the Gods (as well as much else). And by a stroke of luck, an editor of genius had changed her original title, *The View from Olympus*, to *The Passions of the Gods*. Envious academics usually referred to it as *Olympic Lusts*, but invariably wished they had written it.

Not surprisingly, it was Maggie M - as she was quickly christened by her fellow passengers - who first used the phrase *Ship of Fools*. Victor Willis adopted it eagerly, and soon discovered an intriguing historical resonance. Almost a century ago, Katherine Anne Porter had herself sailed with a group of scientists and writers aboard an ocean liner to watch the launch of Apollo 17, and the end of the first phase of lunar exploration.

'I'll think about it,' Ms M'Bala had remarked ominously, when this was reported to her. 'Perhaps it's time for a third version. But I won't know, of course, until we get back to Earth...'

11

The Lie

It was many months before Rolf van der Berg could once again turn his thoughts and energies towards Mount Zeus. The taming of Ganymede was a more than full-time job, and he was away from his main office at Dardanus Base for weeks at a time, surveying the route of the proposed Gilgamesh-Osiris monorail.

The geography of the third and largest Galilean moon had changed drastically since the detonation of Jupiter - and it was still changing. The new sun that had melted the ice of Europa was not as powerful here, four hundred thousand kilometres further out - but it was warm enough to produce a temperate climate at the centre of the face forever turned towards it. There were small, shallow seas - some as large as Earth's Mediterranean - up to latitudes forty north and south. Not many features still survived from the maps generated by the Voyager missions back in the twentieth century. Melting permafrost and occasional tectonic movements triggered by the same tidal forces operating on the two inner moons made the new Ganymede a cartographer's nightmare.

But those very factors also made it a planetary engineer's paradise. Here was the only world, except for the arid and much less hospitable Mars, on which men might one day walk unprotected beneath an open sky. Ganymede had ample water, all the chemicals of life, and - at least while Lucifer shone - a warmer climate than much of Earth.

Best of all, full-body spacesuits were no longer necessary; the atmosphere, though still unbreathable, was just dense enough to permit the use of simple face-masks and oxygen cylinders. In a few decades - so the microbiologists promised, though they were hazy about specific dates - even these could be discarded. Strains of oxygen-generating bacteria had already been let loose across the face of Ganymede; most had died but some had flourished, and the slowly rising curve on the atmospheric analysis chart was the first exhibit proudly displayed to all visitors at Dardanus.

For a long time, van der Berg kept a watchful eye on the data flowing in from Europa VI, hoping that one day the clouds would clear again when it was orbiting above Mount Zeus. He knew that the odds were against it, but while the slightest chance existed he made no effort to explore any other avenue of research. There was no hurry, he had far more important

work on his hands - and anyway, the explanation might turn out to be something quite trivial and uninteresting.

Then Europa VI suddenly expired, almost certainly as a result of a random meteoric impact. Back on Earth, Victor Willis had made rather a fool of himself - in the opinion of many - by interviewing the 'Euronuts' who now more than adequately filled the gap left by the UFO-enthusiasts of the previous century. Some of them argued that the probe's demise was due to hostile action from the world below: the fact that it had been allowed to operate without interference for fifteen years - almost twice its design life - did not bother them in the least. To Victor's credit, he stressed this point and demolished most of the cultists' other arguments; but the consensus was that he should never have given them publicity in the first place.

To van der Berg, who quite relished his colleagues' description of him as a 'stubborn Dutchman' and did his best to live up to it, the failure of Europa VI was a challenge not to be resisted. There was not the slightest hope of funding a replacement, for the silencing of the garrulous and embarrassingly long-lived probe had been received with considerable relief.

So what was the alternative? Van der Berg sat down to consider his options. Because he was a geologist, and not an astrophysicist, it was several days before he suddenly realized that the answer had been staring him in the face ever since he had landed on Ganymede.

Afrikaans is one of the world's best languages in which to curse; even when spoken politely, it can bruise innocent bystanders. Van der Berg let off steam for a few minutes; then he put through a call to the Tiamat Observatory - sitting precisely on the equator, with the tiny, blinding disc of Lucifer forever vertically overhead.

Astrophysicists, concerned with the most spectacular objects in the Universe, tend to patronize mere geologists who devote their lives to small, messy things like planets. But out here on the frontier, everyone helped everyone else, and Dr Wilkins was not only interested but sympathetic.

The Tiamat Observatory had been built for a single purpose, which had indeed been one of the main reasons for establishing a base on Ganymede. The study of Lucifer was of enormous importance not only to pure scientists but also to nuclear engineers, meteorologists, oceanographers - and, not least, to statesmen and philosophers. That there were entities which could turn a planet into a sun was a staggering thought, and had kept many awake at night. It would be well for mankind to learn all it could about the process; one day there might be need to imitate it - or prevent it.

And so for more than a decade Tiamat had been observing Lucifer with every possible type of instrumentation, continually recording its spectrum across the entire electromagnetic band, and also actively probing it with radar from a modest hundred-metre dish, slung across a small impact crater.

'Yes,' said Dr Wilkins, 'we've often looked at Europa and Io. But our beam is fixed on Lucifer, so we can only see them for a few minutes while they're in transit. And your Mount Zeus is just on the dayside, so it's hidden from us then.'

'I realize that,' said van der Berg a little impatiently. 'But couldn't you offset the beam by just a little, so you could have a look at Europa before it comes in line? Ten or twenty degrees would get you far enough into dayside.'

'One degree would be enough to miss Lucifer, and get Europa full-face on the other side of its orbit. But then it would be more than three times further away, so we'd only have a hundredth of the reflected power. Might

work, though: we'll give it a try. Let me have the specs on frequencies, wave envelopes, polarization and anything else your remote-sensing people think will help. It won't take us long to rig up a phase-shifting network that will slew the beam a couple of degrees. More than that I don't know - it's not a problem we've ever considered. Though perhaps we should have done so - anyway, what do you expect to find on Europa, except ice and water?'

'If I knew,' said van der Berg cheerfully, 'I wouldn't be asking for help, would I?'

'And I wouldn't be asking for full credit when you publish. Too bad my name's at the end of the alphabet; you'll be ahead of me by only one letter.'

That was a year ago: the long-range scans hadn't been good enough, and offsetting the beam to look on to Europa's dayside just before conjunction had proved more difficult than expected. But at last the results were in; the computers had digested them, and van der Berg was the first human being to look at a mineralogical map of post-Lucifer Europa.

It was, as Dr Wilkins had surmised, mostly ice and water, with outcroppings of basalt interspersed with deposits of sulphur. But there were two anomalies.

One appeared to be an artefact of the imaging process; there was an absolutely straight feature, two kilometres long, which showed virtually no radar echo. Van der Berg left Dr Wilkins to puzzle over that; he was only concerned with Mount Zeus.

It had taken him a long time to make the identification, because only a madman - or a really desperate scientist - would have dreamed that such a thing was possible. Even now, though every parameter checked to the limits of accuracy, he still could not really believe it. And he had not even attempted to consider his next move.

When Dr Wilkins called, anxious to see his name and reputation spreading through the data banks, he mumbled that he was still analysing the results. But at last he could put it off no longer.

'Nothing very exciting,' he told his unsuspecting colleague. 'Merely a rare form of quartz - I'm still trying to match it from Earth samples.'

It was the first time he had ever lied to a fellow scientist, and he felt terrible about it.

But what was the alternative?

12

Oom Paul

Rolf van der Berg had not seen his Uncle Paul for a decade, and it was not likely that they would ever again meet in the flesh. Yet he felt very close to the old scientist - the last of his generation, and the only one who could recall (when he wished, which was seldom) his forefathers' way of life.

Dr Paul Kreuger - 'Oom Paul' to all his family and most of his friends - was always there when he was needed, with information and advice, either in person or at the end of a half-billion-kilometre radio link. Rumour had it that only extreme political pressure had forced the Nobel Committee - with great reluctance - to overlook his contributions to particle physics, now once more in desperate disarray after the general house-cleaning at the end of the twentieth century.

If this was true, Dr Kreuger bore no grudge. Modest and unassuming, he had no personal enemies, even among the cantankerous factions of his

fellow exiles. Indeed, he was so universally respected that he had received several invitations to re-visit the United States of Southern Africa, but had always politely declined - not, he hastened to explain, because he felt he would be in any physical danger in the USSA, but because he feared that the sense of nostalgia would be overwhelming.

Even using the security of a language now understood by less than a million people, van der Berg had been very discreet, and had used circumlocutions and references that would be meaningless except to a close relative. But Paul had no difficulty in understanding his nephew's message, though he could not take it seriously. He was afraid young Rolf had made a fool of himself, and would let him down as gently as possible. Just as well he hadn't rushed to publish: at least he had the sense to keep quiet...

And suppose - just suppose - it was true? The scanty hairs rose on the back of Paul's head. A whole spectrum of possibilities - scientific, financial, political - suddenly opened up before his eyes, and the more he considered them, the more awesome they appeared.

Unlike his devout ancestors, Dr Kreuger had no God to address in moments of crisis or perplexity. Now, he almost wished he had; but even if he could pray, that wouldn't really help. As he sat down at his computer and started to access the data banks, he did not know whether to hope that his nephew had made a stupendous discovery - or was talking utter nonsense. Could the Old One really play such an incredible trick on mankind? Paul remembered Einstein's famous comment that though He was subtle, He was never malicious.

Stop daydreaming, Dr Paul Kreuger told himself. Your likes or dislikes, your hopes or fears, have absolutely nothing to do with the matter.

A challenge had been flung to him across half the width of the Solar System; he would not know peace until he had uncovered the truth.

13

'No-one told us to bring swimsuits...'

Captain Smith kept his little surprise until day five, just a few hours before turnaround. His announcement was received, as he had expected, with stunned incredulity.

Victor Willis was the first to recover.

'A swimming pool! In a spaceship! You must be joking!'

The Captain leaned back and prepared to enjoy himself. He grinned at Heywood Floyd who had already been let into the secret.

'Well, I suppose Columbus would have been amazed at some of the facilities on the ships that came after him.'

'Is there a diving board?' asked Greenburg wistfully. 'I used to be college champion.'

'As a matter of fact - yes. It's only five metres - but that will give you three seconds of free fall, at our nominal tenth of a gee. And if you want a longer time, I'm sure Mr Curtis will be happy to reduce thrust.'

'Indeed?' said the Chief Engineer dryly. 'And mess up all my orbit calculations? Not to mention the risk of the water crawling out, Surface tension, you know...'

'Wasn't there a space station once that had a spherical swimming pool?' somebody asked.

'They tried it at the hub of Pasteur, before they started the spin,' answered Floyd. 'It just wasn't practical. In zero gravity, it had to be completely enclosed. And you could drown rather easily inside a big sphere of water, if you panicked.'

'One way of getting into the record books - first person to drown in space...'

'No-one told us to bring swimsuits,' complained Maggie M'Bala.

'Anyone who has to wear a swimsuit probably should,' Mihailovich whispered to Floyd.

Captain Smith rapped on the table to restore order. 'This is more important, please. As you know, at midnight we reach maximum speed, and have to start braking. So the drive will shut down at 23.00, and the ship will be reversed. We'll have two hours of weightlessness before we commence thrust again at 01.00.

'As you can imagine, the crew will be rather busy - we'll use the opportunity for an engine check and a hull inspection, which can't be done while we're under power. I strongly advise you to be sleeping then, with the restraint straps lightly fastened across your beds. The stewards will check that there aren't any loose articles that could cause trouble when weight comes on again. Questions?'

There was a profound silence, as if the assembled passengers were still somewhat stunned by the revelation and were deciding what to do about it.

'I was hoping you'd ask me about the economics of such a luxury - but as you haven't, I'll tell you anyway. It's not a luxury at all - it doesn't cost a thing, but we hope it will be a very valuable asset on future voyages.

'You see, we have to carry five thousand tons of water as reaction mass, so we might as well make the best use of it. Number One tank is now three-quarters empty; we'll keep it that way until the end of the voyage. So after breakfast tomorrow - see you down at the beach...

Considering the rush to get Universe spaceborne, it was surprising that such a good job had been done on something so spectacularly non-essential.

The 'beach' was a metal platform, about five metres wide, curving around a third of the great tank's circumference. Although the far wall was only another twenty metres away, clever use of projected images made it seem at infinity. Borne on the waves in the middle distance, surfers were heading towards a shore which they would never reach. Beyond them, a beautiful passenger clipper which any travel agent would recognize instantly as Tsung Sea-Space Corporation's Tai-Pan was racing along the horizon under a full spread of sail.

To complete the illusion, there was sand underfoot (slightly magnetized, so it would not stray too far from its appointed place) and the short length of beach ended in a grove of palm trees which were quite convincing, until examined too closely. Overhead, a hot tropical sun completed the idyllic picture; it was hard to realize that just beyond these walls the real Sun was shining, now twice as fiercely as on any terrestrial beach.

The designer had really done a wonderful job, in the limited space available. It seemed a little unfair of Greenburg to complain: 'Pity there's no surf...'

It is a good principle in science not to believe any 'fact' - however well-attested - until it fits into some accepted frame of reference. Occasionally, of course, an observation can shatter the frame and force the construction of a new one, but that is extremely rare. Galileos and Einsteins seldom appear more than once per century, which is just as well for the equanimity of mankind.

Dr Kreuger fully accepted this principle: he would not believe his nephew's discovery until he could explain it, and as far as he could see that required nothing less than a direct Act of God. Wielding Occam's still highly serviceable razor, he thought it somewhat more probable that Rolf had made a mistake; if so, it should be fairly easy to find it.

To Uncle Paul's great surprise, it proved very difficult indeed. The analysis of radar remote-sensing observations was now a venerable and well-established art, and the experts that Paul consulted all gave the same answer, after considerable delay. They also asked: 'Where did you get that recording?'

'Sorry,' he had answered. 'I'm not at liberty to say.'

The next step was to assume that the impossible was correct, and to start searching the literature. This could be an enormous job, for he did not even know where to begin. One thing was quite certain: a brute-force, head-on attack was bound to fail. It would be just as if Roentgen, the morning after he had discovered X-rays, had started to hunt for their explanation in the physics journals of his day. The information he needed still lay years in the future.

But there was at least a sporting chance that what he was looking for was hidden somewhere in the immense body of existing scientific knowledge. Slowly and carefully, Paul Kreuger set up an automatic search programme, designed for what it would exclude as much as what it would embrace. It should cut out all Earth-related references - they would certainly number in the millions - and concentrate entirely on extraterrestrial citations.

One of the benefits of Dr Kreuger's eminence was an unlimited computer budget: that was part of the fee he demanded from the various organizations who needed his wisdom. Though this search might be expensive, he did not have to worry about the bill.

As it turned out, this was surprisingly small. He was lucky: the search came to an end after only two hours thirty-seven minutes, at the 21,456th reference.

The title was enough. Paul was so excited that his own comsec refused to recognize his voice, and he had to repeat the command for a full print-out.

Nature had published the paper in 1981 - almost five years before he was born! - and as his eyes swept swiftly over its single page he knew not only that his nephew had been right all along - but, just as important, exactly how such a miracle could occur.

The editor of that eighty-year-old journal must have had a good sense of humour. A paper discussing the cores of the outer planets was not something to grab the usual reader: this one, however, had an unusually striking title. His comsec could have told him quickly enough that it had once been part of a famous song, but that of course was quite irrelevant.

Anyway, Paul Kreuger had never heard of the Beatles, and their psychedelic fantasies.



**THE
VALLEY OF
THE BLACK
SNOW**

And now Halley was too close to be seen; ironically, observers back on Earth would get a far better view of the tail, already stretching fifty million kilometres at right angles to the comet's orbit, like a pennant fluttering in the invisible gale of the solar wind.

On the morning of the rendezvous, Heywood Floyd woke early from a troubled sleep. It was unusual for him to dream - or at least to remember his dreams - and doubtless the anticipated excitements of the next few hours were responsible. He was also slightly worried by a message from Caroline, asking if he had heard from Chris lately. He had radioed back, a little tersely, that Chris had never bothered to say thank you when he had helped him get his current position on Universe's sister ship Cosmos; perhaps he was already bored with the Earth-Moon run and was looking for excitement elsewhere.

'As usual,' Floyd had added, 'we'll hear from him in his own good time.'

Immediately after breakfast, passengers and science team had gathered for a final briefing from Captain Smith. The scientists certainly did not need it, but if they felt any irritation, so childish an emotion would have been quickly swept away by the weird spectacle on the main viewscreen.

It was easier to imagine that Universe was flying into a nebula, rather than a comet. The entire sky ahead was now a misty white fog - not uniform, but mottled with darker condensations and streaked with luminous bands and brightly glowing jets, all radiating away from a central point. At this magnification, the nucleus was barely visible as a

tiny black speck, yet it was clearly the source of all the phenomena around it.

'We cut our drive in three hours,' said the Captain. 'Then we'll be only a thousand kilometres away from the nucleus, with virtually zero velocity. We'll make some final observations, and confirm our landing site.'

'So we'll go weightless at 12.00 exactly. Before then, your cabin stewards will check that everything's correctly stowed. It will be just like turnaround, except that this time it's going to be three days, not two hours, before we have weight again.

'Halley's gravity? Forget it - less than one centimetre per second squared - just about a thousandth of Earth's. You'll be able to detect it if you wait long enough, but that's all. Takes fifteen seconds for something to fall a metre.

'For safety, I'd like you all here in the observation lounge, with your seat belts properly secured, during rendezvous and touchdown. You'll get the best view from here anyway, and the whole operation won't take more than an hour. We'll only be using very small thrust corrections, but they may come from any angle and could cause minor sensory disturbances.'

What the Captain meant, of course, was spacesickness - but that word, by general agreement, was taboo aboard Universe. It was noticeable, however, that many hands strayed into the compartments beneath the seats, as if checking that the notorious plastic bags would be available if urgently required.

The image on the viewscreen expanded, as the magnification was increased. For a moment it seemed to Floyd that he was in an aeroplane, descending through light clouds, rather than in a spacecraft approaching the most famous of all comets. The nucleus was growing larger and clearer; it was no longer a black dot, but an irregular ellipse - now a small,

pockmarked island lost in the cosmic ocean - then, suddenly, a world in its own right.

There was still no sense of scale. Although Floyd knew that the whole panorama spread before him was less than ten kilometres across, he could easily have imagined that he was looking at a body as large as the Moon. But the Moon was not hazy around the edges, nor did it have little jets of vapour - and two large ones - spurting from its surface.

'My God!' cried Mihailovich, 'what's that?'

He pointed to the lower edge of the nucleus, just inside the terminator. Unmistakably - impossibly - a light was flashing there on the nightside of the comet with a perfectly regular rhythm: on, off, on, off, once every two or three seconds.

Dr Willis gave his patient 'I can explain it to you in words of one syllable' cough, but Captain Smith got there first.

'I'm sorry to disappoint you, Mr Mihailovich. That's only the beacon on Sampler Probe Two - it's been sitting there for a month, waiting for us to come and pick it up.'

'What a shame; I thought there might be someone - something - there to welcome us.'

'No such luck, I'm afraid; we're very much on our own out here. That beacon is just where we intend to land - it's near Halley's south pole and is in permanent darkness at the moment. That will make it easier on our life-support systems. The temperature's up to 120 degrees on the Sunlit side - way above boiling point.'

'No wonder the comet's perking,' said the unabashed Dimitri. 'Those jets don't look very healthy to me. Are you sure it's safe to go in?'

'That's another reason we're touching down on the nightside; there's no activity there. Now, if you'll excuse me, I must get back to the bridge. This is the first chance I've ever had of landing on a new world - and I doubt if I'll get another.'

Captain Smith's audience dispersed slowly, and in unusual silence. The image on the viewscreen zoomed back to normal, and the nucleus dwindled once more to a barely visible spot. Yet even in those few minutes it seemed to have grown slightly larger, and perhaps that was no illusion. Less than four hours before encounter, the ship was still hurtling towards the comet at fifty thousand kilometres an hour.

It would make a crater more impressive than any that Halley now boasted, if something happened to the main drive at this stage of the game.

16

Touchdown

The landing was just as anticlimactic as Captain Smith had hoped. It was impossible to tell the moment when Universe made contact; a full minute elapsed before the passengers realized that touchdown was complete, and raised a belated cheer.

The ship lay at one end of a shallow valley, surrounded by hills little more than a hundred metres high. Anyone who had been expecting to see a lunar landscape would have been greatly surprised; these formations bore no resemblance at all to the smooth, gentle slopes of the Moon, sand-blasted by micrometeorite bombardment over billions of years.

There was nothing here more than a thousand years old; the Pyramids were far more ancient than this landscape. Every time around the Sun,

Halley was remoulded - and diminished - by the solar fires. Even since the 1986 perihelion passage, the shape of the nucleus had been subtly changed. Melding metaphors shamelessly, Victor Willis had nevertheless put it rather well when he told his viewers: "The "peanut" has become wasp-waisted!"

Indeed, there were indications that, after a few more revolutions round the Sun, Halley might split into two roughly equal fragments - as had Biela's comet, to the amazement of the astronomers of 1846.

The virtually non-existent gravity also contributed to the strangeness of the landscape. All around were spidery formations like the fantasies of a surrealist artist, and improbably canted rockpiles that could not have survived more than a few minutes even on the Moon.

Although Captain Smith had chosen to land Universe in the depths of the polar night - all of five kilometres from the blistering heat of the Sun - there was ample illumination. The huge envelope of gas and dust surrounding the comet formed a glowing halo which seemed appropriate for this region; it was easy to imagine that it was an aurora, playing over the Antarctic ice. And if that was not sufficient, Lucifer provided its quota of several hundred full moons.

Although expected, the complete absence of colour was a disappointment; Universe might have been sitting in an opencast coal mine: that, in fact, was not a bad analogy, for much of the surrounding blackness was due to carbon or its compounds, intimately mixed with snow and ice.

Captain Smith, as was his due, was the first to leave the ship, pushing himself gently out from Universe's main airlock. It seemed an eternity before he reached the ground, two metres below; then he picked up a handful of the powdery surface, and examined it in his gloved hand.

Aboard the ship, everyone waited for the words that would go into the history books.

'Looks like pepper and salt,' said the Captain. 'If it were thawed out, it might grow a pretty good crop.'

* * *

The mission plan involved one complete Halley 'day' of fifty-five hours at the south pole, then - if there were no problems - a move of ten kilometres towards the very ill-defined equator, to study one of the geysers during a complete day-night cycle.

Chief Scientist Pendrill wasted no time. Almost immediately, he set off with a colleague on a two-man jet-sled towards the beacon of the waiting probe. They were back within the hour, bearing prepackaged samples of comet which they proudly consigned to the deep-freeze.

Meanwhile the other teams established a spider's web of cables along the valley, strung between poles driven into the friable crust. These served not only to link numerous instruments to the ship, but also made movement outside much easier. One could explore this portion of Halley without the use of cumbersome External Manoeuvring Units; it was only necessary to attach a tether to a cable, and then go along it hand over hand. That was also much more fun than operating EMUs, which were virtually one-man spaceships with all the complications they involved.

The passengers watched all this with fascination, listening to the radioed conversations and trying to join in the excitement of discovery. After about twelve hours - considerably less in the case of ex-astronaut Clifford Greenburg - the pleasure of being a captive audience started to

pall. Soon there was much talk about 'going outside' except from Victor Willis who was quite uncharacteristically subdued.

'I think he's scared,' said Dimitri contemptuously. He had never liked Victor, since discovering that the scientist was completely tone-deaf. Though this was wildly unfair to Victor (who had gamely allowed himself to be used as a guinea pig for studies of his curious affliction) Dimitri was fond of adding darkly 'A man that hath no music in himself, Is fit for treasons, stratagems and spoils.'

Floyd had made up his mind even before leaving Earth orbit. Maggie M was game enough to try anything and would need no encouragement. (Her slogan 'An author should never turn down the opportunity for a new experience' had impacted famously on her emotional life.)

Yva Merlin, as usual, had kept everyone in suspense, but Floyd was determined to take her on a personal tour of the comet. It was the very least he could do to maintain his reputation; everyone knew that he had been partly responsible for getting the fabulous recluse on the passenger list, and now it was a running joke that they were having an affair. Their most innocent remarks were gleefully misinterpreted by Dimitri and the ship's physician Dr Mahindran, who professed to regard them with envious awe.

After some initial annoyance - because it all too accurately recalled the emotions of his youth - Floyd had gone along with the joke. But he did not know how Yva felt about it, and had so far lacked the courage to ask her. Even now, in this compact little society where few secrets lasted more than six hours, she maintained much of her famous reserve - that aura of mystery which had fascinated audiences for three generations.

As for Victor Willis, he had just discovered one of those devastating little details that can destroy the best-laid plans of mice and spacemen.

Universe was equipped with the latest Mark XX suits, with non-fogging, non-reflective visors guaranteed to give an unparalleled view of space. And though the helmets came in several sizes, Victor Willis could not get into any of them without major surgery.

It had taken him fifteen years to perfect his trademark ('a triumph of the topiary art,' one critic had called it, perhaps admiringly).

Now only his beard stood between Victor Willis and Halley's Comet. Soon he would have to make a choice between the two.

17

The Valley of Black Snow

Captain Smith had raised surprisingly few objections to the idea of passenger EVAs. He agreed that to have come all this way, and not to set foot upon the comet, was absurd.

'There'll be no problems if you follow instructions,' he said at the inevitable briefing. 'Even if you've never worn spacesuits before - and I believe that only Commander Greenburg and Dr Floyd have done so - they're quite comfortable, and fully automatic. There's no need to bother about any controls or adjustments, after you've been checked out in the airlock.

'One absolute rule: only two of you can go EVA at one time. You'll have a personal escort, of course, linked to you by five metres of safety line - though that can be played out to twenty if necessary. In addition, you'll both be tethered to the two guide-cables we've strung the whole length of the valley. The rule of the road is the same as on Earth; keep to the right! If you want to overtake anyone, you only have to unclip your

buckle - but one of you must always remain attached to the line. That way, there's no danger of drifting off into space. Any questions?'

'How long can we stay out?'

'As long as you like, Ms M'Bala. But I recommend that you return just as soon as you feel the slightest discomfort. Perhaps an hour would be best for the first outing - though it may seem like only ten minutes...'

Captain Smith had been quite correct. As Heywood Floyd looked at his time-elapsd display, it seemed incredible that forty minutes had already passed. Yet it should not have been so surprising, for the ship was already a good kilometre away.

As the senior passenger - by almost any reckoning - he had been given the privilege of making the first EVA. And he really had no choice of companion.

'EVA with Yva!' chortled Mihailovich. 'How can you possibly resist! Even if,' he added with a lewd grin, 'those damn suits won't let you try all the Extravehicular Activities you'd like,'

Yva had agreed, without any hesitation, yet also without any enthusiasm. That, Floyd thought wryly, was typical. It would not be quite true to say that he was disillusioned - at his age, he had very few illusions left - but he was disappointed. And with himself rather than Yva; she was as beyond criticism or praise as the Mona Lisa - with whom she had often been compared.

The comparison was, of course, ridiculous; La Gioconda was mysterious, but she was certainly not erotic. Yva's power had lain in her unique combination of both - with innocence thrown in for good measure. Half a century later, traces of all three ingredients were still visible, at least to the eye of faith.

What was lacking - as Floyd had been sadly forced to admit - was any real personality. When he tried to focus his mind upon her, all he could visualize were the roles she had played. He would have reluctantly agreed with the critic who had once said:

'Yva Merlin is the reflection of all men's desires; but a mirror has no character.'

And now this unique and mysterious creature was floating beside him across the face of Halley's Comet, as they and their guide moved along the twin cables that spanned the Valley of Black Snow. That was his name; he was childishly proud of it, even though it would never appear on any map. There could be no maps of a world where geography was as ephemeral as weather on Earth. He savoured the knowledge that no human eye had ever before looked upon the scene around him - or ever would again.

On Mars, or on the Moon, you could sometimes -with a slight effort of imagination, and if you ignored the alien sky - pretend that you were on Earth. This was impossible here, because the towering - often overhanging - snow sculptures showed only the slightest concession to gravity. You had to look very carefully at your surroundings to decide which way was up.

The Valley of Black Snow was unusual, because it was a fairly solid structure - a rocky reef embedded in volatile drifts of water and hydrocarbon ice. The geologists were still arguing about its origin, some maintaining that it was really part of an asteroid that had encountered the comet ages ago. Corings had revealed complex mixtures of organic compounds, rather like frozen coal-tar - though it was certain that life had never played any part in their formation.

The 'snow' carpeting of the floor of the little valley was not completely black; when Floyd raked it with the beam of his flashlight it glittered and sparkled as if embedded with a million microscopic diamonds. He wondered if there were indeed diamonds on Halley: there was certainly

enough carbon here. But it was almost equally certain that the temperatures and pressures necessary to create them had never existed here.

On a sudden impulse, Floyd reached down and gathered two handfuls of the snow: he had to push with his feet against the safety line to do so, and had a comic vision of himself as a trapeze artist walking a tightrope - but upside down. The fragile crust offered virtually no resistance as he buried head and shoulders into it; then he pulled gently on his tether and emerged with his handful of Halley.

He wished that he could feel it through the insulation of his gloves, as he compacted the mass of crystalline fluff into a ball that just fitted the palm of his hand. There it lay, ebony black yet giving fugitive flashes of light as he turned it from side to side.

And suddenly, in his imagination, it became the purest white - and he was a boy again, in the winter playground of his youth, surrounded with the ghosts of his childhood. He could even hear the cries of his companions, taunting and threatening him with their own projectiles of immaculate snow...

The memory was brief, but shattering, for it brought an overwhelming sensation of sadness. Across a century of time, he could no longer remember a single one of those phantom friends who stood around him; yet some, he knew, he had once loved...

His eyes filled with tears, and his fingers clenched around the ball of alien snow. Then the vision faded; he was himself again. This was not a moment of sadness, but of triumph.

'My God!' cried Heywood Floyd, his words echoing in the tiny, reverberant universe of his spacesuit, 'I'm standing on Halley's Comet - what more do I want! If a meteor hits me now, I won't have a single complaint!'

He brought up his arms and launched the snowball towards the stars. It was so small, and so dark, that it vanished almost at once, but he kept on staring into the sky.

And then, abruptly - unexpectedly - it appeared in a sudden explosion of light, as it rose into the rays of the hidden Sun. Black as soot though it was, it reflected enough of that blinding brilliance to be easily visible against the faintly luminous sky.

Floyd watched it until it finally disappeared - perhaps by evaporation, perhaps by dwindling into the distance. It would not last long in the fierce torrent of radiation overhead; but how many men could claim to have created a comet of their own?

18

'Old Faithful'

The cautious exploration of the comet had already begun while Universe still remained in the polar shadow. First, one-man EMUs (few people now knew that stood for External Manoeuvring Unit) gently jettied over both day- and nightside, recording everything of interest. Once the preliminary surveys had been completed, groups of up to five scientists flew out in the onboard shuttle, deploying equipment and instruments at strategic spots.

The Lady Jasmine was a far cry from the primitive 'space pods' of the Discovery era, capable of operating only in a gravity-free environment. She was virtually a small spaceship, designed to ferry personnel and light cargo between the orbiting Universe and the surfaces of Mars, Moon, or the Jovian satellites. Her chief pilot, who treated her like the grande dame

she was, complained with mock bitterness that flying round a miserable little comet was far beneath her dignity.

When he was quite sure that Halley - on the surface at least - held no surprises, Captain Smith lifted away from the pole. Moving less than a dozen kilometres took Universe to a different world, from a glimmering twilight that would last for months to a realm that knew the cycle of night and day. And with the dawn, the comet came slowly to life.

As the Sun crept above the jagged, absurdly close horizon, its rays would slant down into the countless small craters that pockmarked the crust. Most of them would remain inactive, their narrow throats sealed by incrustations of mineral salts. Nowhere else on Halley were such vivid displays of colour; they had misled biologists into thinking that here life was beginning, as it had on Earth, in the form of algal growths. Many had not yet abandoned that hope, though they would be reluctant to admit it.

From other craters, wisps of vapour floated up into the sky, moving in unnaturally straight trajectories because there were no winds to divert them. Usually nothing else happened for an hour or two; then, as the Sun's warmth penetrated to the frozen interior, Halley would begin to spurt - as Victor Willis had put it 'like a pod of whales'.

Though picturesque, it was not one of his more accurate metaphors. The jets from the dayside of Halley were not intermittent, but played steadily for hours at a time. And they did not curl over and fall back to the surface, but went rising on up into the sky, until they were lost in the glowing fog which they helped create.

At first, the science team treated the geysers as cautiously as if they were volcanologists approaching Etna or Vesuvius in one of their less predictable moods. But they soon discovered that Halley's eruptions, though often fearsome in appearance, were singularly gentle and well-behaved; the water emerged about as fast as from an ordinary firehose, and was barely warm. Within seconds of escaping from its underground

reservoir, it would flash into a mixture of vapour and ice crystals; Halley was enveloped in a perpetual snowstorm, falling upwards... Even at this modest speed of ejection, none of the water would ever return to its source. Each time it rounded the Sun, more of the comet's life-blood would haemorrhage into the insatiable vacuum of space.

After considerable persuasion, Captain Smith agreed to move Universe to within a hundred metres of 'Old Faithful', the largest geyser on the dayside. It was an awesome sight - a whitish-grey column of mist, growing like some giant tree from a surprisingly small orifice in a three-hundred-metre-wide crater which appeared to be one of the oldest formations on the comet. Before long, the scientists were scrambling all over the crater, collecting specimens of its (completely sterile, alas) multi-coloured minerals, and casually thrusting their thermometers and sampling tubes into the soaring water-ice-mist column itself. 'If it tosses any of you out into space,' warned the Captain, 'don't expect to be rescued in a hurry. In fact, we may just wait until you come back.'

'What does he mean by that?' a puzzled Dimitri Mihailovich had asked. As usual, Victor Willis was quick with the answer.

'Things don't always happen the way you'd expect in celestial mechanics. Anything thrown off Halley at a reasonable speed will still be moving in essentially the same orbit - it takes a huge velocity change to make a big difference. So one revolution later, the two orbits will intersect again - and you'll be right back where you started. Seventy-six years older, of course.'

Not far from Old Faithful was another phenomenon which no-one could reasonably have anticipated. When they first observed it, the scientists could scarcely believe their eyes. Spread out across several hectares of Halley, exposed to the vacuum of space, was what appeared to be a perfectly ordinary lake, remarkable only for its extreme blackness.

Obviously, it could not be water; the only liquids which could be stable in this environment were heavy organic oils or tars. In fact, 'Lake Tuonela' turned out to be more like pitch, quite solid except for a sticky surface layer less than a millimetre thick. In this negligible gravity, it must have taken years - perhaps several trips round the warming fires of the Sun - for it to have assumed its present mirror-flatness.

Until the Captain put a stop to it, the lake became one of the principal tourist attractions on Halley's Comet. Someone (nobody claimed the dubious honour) discovered that it was possible to walk perfectly normally across it, almost as if on Earth; the surface film had just enough adhesion to hold the foot in place. Before long, most of the crew had got themselves videoed apparently walking on water...

Then Captain Smith inspected the airlock, discovered the walls liberally stained with tar, and gave the nearest thing to a display of anger that anyone had ever witnessed from him.

'It's bad enough,' he said through clenched teeth, 'having the outside of the ship coated with - soot. Halley's Comet is about the filthiest place I've ever seen...'

After that, there were no more strolls on Lake Tuonela.

19

At the End of the Tunnel

In a small, self-contained universe where everyone knows everyone else, there can be no greater shock than encountering a total stranger.

Heywood Floyd was floating gently along the corridor to the main lounge when he had this disturbing experience. He stared in amazement at the interloper, wondering how a stowaway had managed to avoid detection for so long. The other man looked back at him with a combination of embarrassment and bravado, obviously waiting for Floyd to speak first.

'Well, Victor!' he said at last. 'Sorry I didn't recognize you. So you've made the supreme sacrifice, for the cause of science - or should I say your public?'

'Yes,' Willis answered grumpily. 'I did manage to squeeze into one helmet - but the damn bristles made so many scratching noises no-one could hear a word I said.'

'When are you going out?'

'Just as soon as Cliff comes back - he's gone caving with Bill Chant.'

The first flybys of the comet, in 1986, had suggested that it was considerably less dense than water -which could only mean that it was either made of very porous material, or was riddled with cavities. Both explanations turned out to be correct.

At first, the ever-cautious Captain Smith flatly forbade any cave-exploring. He finally relented when Dr Pendrill reminded him that his chief assistant Dr Chant was an experienced speleologist - indeed, that was one of the very reasons he had been chosen for the mission.

'Cave-ins are impossible, in this low gravity,' Pendrill had told the reluctant Captain. 'So there's no danger of being trapped.'

'What about being lost?'

'Chant would regard that suggestion as a professional insult. He's been twenty kilometres inside Mammoth Cave. Anyway, he'll play out a guideline.'

'Communications?'

'The line's got fibre optics in it. And his suit radio will probably work most of the way.'

'Umm. Where does he want to go in?'

'The best place is that extinct geyser at the base of Etna Junior. It's been dead for at least a thousand years.'

'So I suppose it should keep quiet for another couple of days. Very well - does anyone else want to go?'

'Cliff Greenburg has volunteered - he's done a good deal of underwater cave-exploring, in the Bahamas.'

'I tried it once - that was enough. Tell Cliff he's much too valuable. He can go in as far as he can still see the entrance - and no further. And if he loses contact with Chant, he's not to go after him, without my authority.'

Which, the Captain added to himself, I would be very reluctant to give...

Dr Chant knew all the old jokes about speleologists wanting to return to the womb, and was quite sure he could refute them.

'That must be a damn noisy place, with all its thumpings and bumpings and gurglings,' he argued. 'I love caves because they're so peaceful and

timeless. You know that nothing has changed for a hundred thousand years, except that the stalactites have grown a bit thicker.'

But now, as he drifted deeper into Halley, playing out the thin, but virtually unbreakable thread that linked him to Clifford Greenburg, he realized that this was no longer true. As yet, he had no scientific proof, but his geologist's instincts told him that this subterranean world had been born only yesterday, on the time-scale of the Universe. It was younger than some of the cities of man.

The tunnel through which he was gliding in long, shallow leaps was about four metres in diameter, and his virtual weightlessness brought back vivid memories of cave-diving on Earth. The low gravity contributed to the illusion; it was exactly as if he was carrying slightly too much weight, and so kept drifting gently downwards. Only the absence of all resistance reminded him that he was moving through vacuum, not water.

'You're just getting out of sight,' said Greenburg, fifty metres in from the entrance. 'Radio link still fine. What's the scenery like?'

'Very hard to say - I can't identify any formations, so I don't have the vocabulary to describe them. It's not any kind of rock - it crumbles when I touch it - I feel as if I'm exploring a giant Gruyère cheese.'

'You mean it's organic?'

'Yes - nothing to do with life, of course - but perfect raw material for it. All sorts of hydrocarbons - the chemists will have fun with these samples. Can you still see me?'

'Only the glow of your light, and that's fading fast.'

'Ah - here's some genuine rock - doesn't look as if it belongs here - probably an intrusion - ah - I've struck gold!'

'You're joking!'

'It fooled a lot of people in the old West - iron pyrites. Common on the outer satellites, of course, but don't ask me what it's doing here...'

'Visual contact lost. You're two hundred metres in.'

'I'm passing through a distinct layer - looks like meteoric debris - something exciting must have happened back then - I hope we can date it - wow!'

'Don't do that sort of thing to me!'

'Sorry - quite took my breath away - there's a big chamber ahead - last thing I expected - let me swing the beam around...'

'Almost spherical - thirty, forty metres across. And - I don't believe it - Halley is full of surprises - stalactites, stalagmites.'

'What's so surprising about that?'

'No free water, no limestone here, of course - and such low gravity. Looks like some kind of wax. Just a minute while I get good video coverage... fantastic shapes... sort of thing a dripping candle makes... that's odd...'

'Now what?'

Dr Chant's voice had shown a sudden alteration in tone, which Greenburg had instantly detected.

'Some of the columns have been broken. They're lying on the floor. It's almost as if...'

'Go on!'

'... as if something has - blundered - into them.'

'That's crazy. Could an earthquake have snapped them?'

'No earthquakes here - only microseisms from the geysers. Perhaps there was a big blow-out at some time. Anyway, it was centuries ago. There's a film of this wax stuff over the fallen columns - several millimetres thick.'

Dr Chant was slowly recovering his composure. He was not a highly imaginative man - spelunking eliminates such men rather quickly - but the very feel of the place had triggered some disturbing memory. And those fallen columns looked altogether too much like the bars of a cage, broken by some monster in an attempt to escape.

Of course, that was perfectly absurd - but Dr Chant had learned never to ignore any premonition, any danger signal, until he had traced it to its origin. That caution had saved his life more than once; he would not go beyond this chamber until he had identified the source of his fear. And he was honest enough to admit that 'fear' was the correct word.

'Bill - are you all right? What's happening?'

'Still filming. Some of these shapes remind me of Indian temple sculpture. Almost erotic.'

He was deliberately turning his mind away from the direct confrontation of his fears, hoping thereby to sneak up on them unawares, by a kind of averted mental vision. Meanwhile the purely mechanical acts of recording and collecting samples occupied most of his attention.

There was nothing wrong, he reminded himself, with healthy fear; only when it escalated into panic did it become a killer. He had known panic twice in his life (once on a mountainside, once underwater) and still

shuddered at the memory of its clammy touch. Yet - thankfully - he was far from it now, and for a reason which, though he did not understand it, he found curiously reassuring. There was an element of comedy in the situation.

And presently he started to laugh - not with hysteria, but with relief.

'Did you ever see those old Star Wars movies?' he asked Greenburg.

'Of course - half a dozen times.'

'Well, I know what's been bothering me. There was a sequence when Luke's spaceship dives into an asteroid - and runs into a gigantic snake-creature that lurks inside its caverns.'

'Not Luke's ship - Hans Solo's Millennium Falcon. And I always wondered how that poor beast managed to eke out a living. It must have grown very hungry, waiting for the occasional titbit from space. And Princess Leia wouldn't have been more than an hors-d'oeuvre, anyway.'

'Which I certainly don't intend to provide,' said Dr Chant, now completely at ease. 'Even if there is life here - which would be marvellous - the food chain would be very short. So I'd be surprised to find anything bigger than a mouse. Or, more likely, a mushroom... Now let's see - where do we go from here... There are two exits on the other side of the chamber... the one on the right is bigger... I'll take that...'

'How much more line have you got?'

'Oh, a good half-kilometre. Here we go... I'm in the middle of the chamber... damn, bounced off the wall... now I've got a hand-hold... going in head-first... smooth walls, real rock for a change... that's a pity..'

'What's the problem?'

'Can't go any further. More stalactites... too close together for me to get through... and too thick to break without explosives. And that would be a shame... the colours are beautiful... first real greens and blues I've seen on Halley. Just a minute while I get them on video...

Dr Chant braced himself against the wall of the narrow tunnel, and aimed the camera. With his gloved fingers he reached for the HI-INTENSITY switch, but missed it and cut off the main lights completely.

'Lousy design,' he muttered. 'Third time I've done that.'

He did not immediately correct his mistake, because he had always enjoyed that silence and total darkness which can be experienced only in the deepest caves. The gentle background noises of his life-support equipment robbed him of the silence, but at least...

What was that? From beyond the portcullis of stalactites blocking further progress he could see a faint glow, like the first light of dawn. As his eyes grew adapted to the darkness, it appeared to grow brighter, and he could detect a hint of green. Now he could even see the outlines of the barrier ahead.

'What's happening?' said Greenburg anxiously.

'Nothing - just observing.'

And thinking, he might have added. There were four possible explanations.

Sunlight could be filtering down through some natural light duct - ice, crystal, whatever. But at this depth? Unlikely.

Radioactivity? He hadn't bothered to bring a counter; there were virtually no heavy elements here. But it would be worth coming back to check.

Some phosphorescent mineral - that was the one he'd put his money on. But there was a fourth possibility - the most unlikely, and most exciting, of all.

Dr Chant had never forgotten a moonless - and Luciferless - night on the shores of the Indian Ocean, when he had been walking beneath brilliant stars along a sandy beach. The sea was very calm, but from time to time a languid wave would collapse at his feet - and detonate in an explosion of light.

He had walked out into the shallows (he could still remember the feel of the water round his ankles, like a warm bath) and with every step he took there had been another burst of light. He could even trigger it by clapping his hands close to the surface.

Could similar bioluminescent organisms have evolved, here in the heart of Halley's Comet? He would love to think so. It seemed a pity to vandalize something so exquisite as this natural work of art - with the glow behind it, the barrier now reminded him of an altar screen he had once seen in some cathedral - but he would have to go back and get some explosives. Meanwhile, there was the other corridor...

'I can't get any further along this route,' he told Greenburg, 'so I'll try the other. Coming back to the junction - setting the reel on rewind.' He did not mention the mysterious glow, which had vanished as soon as he switched on his lights again.

Greenburg did not reply immediately, which was unusual; probably he was talking to the ship. Chant did not worry; he would repeat his message as soon as he had got under way again.

He did not bother, because there was a brief acknowledgement from Greenburg.

'Fine, Cliff - thought I'd lost you for a minute. Back at the chamber - now going into the other tunnel - hope there's nothing blocking that.'

This time, Greenburg replied at once.

'Sorry, Bill. Come back to the ship. There's an emergency - no, not here - everything's fine with Universe. But we may have to return to Earth at once.'

It was only a few weeks before Dr Chant discovered a very plausible explanation for the broken columns. As the comet blasted its substance away into space at each perihelion passage, its mass distribution continually altered. And so, every few thousand years, its spin became unstable, and it would change the direction of its axis - quite violently, like a top that is about to fall over as it loses energy. When that occurred, the resulting cometquake could reach a respectable five on the Richter scale.

But he never solved the mystery of the luminous glow. Though the problem was swiftly overshadowed by the drama that was now unfolding, the sense of a missed opportunity would continue to haunt him for the rest of his life.

Though he was occasionally tempted, he never mentioned it to any of his colleagues. But he did leave a sealed note for the next expedition, to be opened in 2133.

'Have you seen Victor?' said Mihailovich gleefully, as Floyd hurried to answer the Captain's summons. 'He's a broken man.'

'He'll grow it back on the way home,' snapped Floyd, who had no time for such trivialities at the moment. 'I'm trying to find out what's happened.'

Captain Smith was still sitting, almost stunned, in his cabin when he arrived. If this was an emergency affecting his own ship, he would have been a tornado of controlled energy, issuing orders right and left. But there was nothing he could do about this situation, except await the next message from Earth.

Captain Laplace was an old friend; how could he have got into such a mess? There was no conceivable accident, error of navigation, or failure of equipment that could possibly account for his predicament. Nor, as far as Smith could see, was there any way in which Universe could help him get out of it. Operations Centre was just running round and round in circles; this looked like one of those emergencies, all too common in space, where nothing could be done except transmit condolences and record last messages. But he gave no hint of his doubts and reservations when he reported the news to Floyd.

'There's been an accident,' he said. 'We've received orders to return to Earth immediately, to be fitted out for a rescue mission.'

'What kind of accident?'

'It's our sister ship, Galaxy. She was doing a survey of the Jovian satellites. And she's made a crash landing.'

He saw the look of amazed incredulity on Floyd's face.

'Yes, I know that's impossible. But you've not heard anything yet. She's stranded - on Europa.'

'Europa!'

'I'm afraid so. She's damaged, but apparently there's no loss of life. We're still awaiting details.'

'When did it happen?'

'Twelve hours ago. There was a delay before she could report to Ganymede.'

'But what can we do? We're on the other side of the Solar System. Getting back to lunar orbit to refuel, then taking the fastest orbit to Jupiter - it would be - oh, at least a couple of months!' (And back in Leonov's day, Floyd added to himself, it would have been a couple of years...)

'I know; but there's no other ship that could do anything.' -

'What about Ganymede's own inter-satellite ferries?'

'They're only designed for orbital operations.'

'They've landed on Callisto.'

'Much lower energy mission. Oh, they could just manage Europa, but with negligible payload. It's being looked into, of course.'

Floyd scarcely heard the Captain; he was still trying to assimilate this astonishing news. For the first time in half a century - and only for the second time in all history! - a ship had landed on the forbidden moon. And that prompted an ominous thought.

'Do you suppose,' he asked, 'that - whoever - whatever - is on Europa could be responsible?'

'I was wondering about that,' said the Captain glumly. 'But we've been snooping around the place for years, without anything happening.'

'Even more to the point - what might happen to us if we attempted a rescue?'

'That's the first thing that occurred to me. But all this is speculation - we'll have to wait until we have more facts. Meanwhile - this is really why I called you - I've just received Galaxy's crew manifest, and I was wondering...'

Hesitantly, he pushed the print-out across his desk. But even before Heywood Floyd scanned the list, he somehow knew what he would find.

'My grandson,' he said bleakly.

And, he added to himself, the only person who can carry my name beyond the grave.



**EUROPEAN
ROULETTE**

Despite all the gloomier forecasts, the South African Revolution had been comparatively bloodless - as such things go. Television, which had been blamed for many evils, deserved some credit for this. A precedent had been set a generation earlier in the Philippines; when they know that the world is watching, the great majority of men and women tend to behave in a responsible manner. Though there have been shameful exceptions, few massacres occur on camera.

Most of the Afrikaners, when they recognized the inevitable, had left the country long before the takeover of power. And - as the new administration bitterly complained - they had not gone empty-handed. Billions of rands had been transferred to Swiss and Dutch banks; towards the end, there had been mysterious flights almost every hour out of Cape Town and Jo'burg to Zurich and Amsterdam. It was said that by Freedom Day one would not find one troy ounce of gold or a carat of diamond in the late Republic of South Africa - and the mine workings had been effectively sabotaged. One prominent refugee boasted, from his luxury apartment in The Hague, 'It will be five years before the Kaffirs can get Kimberley working again - if they ever do.' To his great surprise, De Beers was back in business, under new name and management, in less than five weeks, and diamonds were now the single most important element in the new nation's economy.

Within a generation, the younger refugees had been absorbed - despite desperate rearguard actions by their conservative elders - in the deracinated culture of the twenty-first century. They recalled, with pride but without boastfulness, the courage and determination of their ancestors,

and distanced themselves from their stupidities. Virtually none of them spoke Afrikaans, even in their own homes.

Yet, precisely as in the case of the Russian Revolution a century earlier, there were many who dreamed of putting back the clock - or, at least, of sabotaging the efforts of those who had usurped their power and privilege. Usually they channelled their frustration and bitterness into propaganda, demonstrations, boycotts, petitions to the World Council - and, rarely, works of art. Wilhelm Smuts' *The Voortrekkers* was conceded to be a masterpiece of (ironically) English literature, even by those who bitterly disagreed with the author.

But there were also groups who believed that political action was useless, and that only violence would restore the longed-for status quo. Although there could not have been many who really imagined that they could rewrite the pages of history, there were not a few who, if victory was impossible, would gladly settle for revenge.

Between the two extremes of the totally assimilated and the completely intransigent, there was an entire spectrum of political - and apolitical - parties. *Der Bund* was not the largest, but it was the most powerful, and certainly the richest, since it controlled much of the lost Republic's smuggled wealth, through a network of corporations and holding companies. Most of these were now perfectly legal, and indeed completely respectable.

There was half a billion of Bund money in *Tsung Aerospace*, duly listed in the annual balance sheet. In 2059, Sir Lawrence was happy to receive another half-billion, which enabled him to accelerate the commissioning of his little fleet.

But not even his excellent intelligence traced any connection between the Bund and *Tsung Aerospace's* latest charter mission, In any event, Halley was then approaching Mars, and Sir Lawrence was so busy getting

Universe ready to leave on schedule that he paid little attention to the routine operations of her sister ships.

Though Lloyd's of London did raise some queries about Galaxy's proposed routing, these objections were quickly dealt with. The Bund had people in key positions everywhere; which was unfortunate for the insurance brokers, but very good luck for the space lawyers.

22

Hazardous Cargo

It is not easy to run a shipping line between destinations which not only change their positions by millions of kilometres every few days, but also swing through a velocity range of tens of kilometres a second. Anything like a regular schedule is out of the question; there are times when one must forget the whole idea and stay in port - or at least in orbit - waiting for the Solar System to rearrange itself for the greater convenience of mankind.

Fortunately, these periods are known years in advance, so it is possible to make the best use of them for overhauls, retrofits, and planet leave for the crew. And occasionally, by good luck and aggressive salesmanship, one can arrange some local chartering, even if only the equivalent of the old-time 'Once around the Bay' boat-ride.

Captain Eric Laplace was delighted that the three-month stayover off Ganymede would not be a complete loss. An anonymous and unexpected grant to the Planetary Science Foundation would finance a reconnaissance of the Jovian (even now, no-one ever called it Luciferian) satellite system, paying particular attention to a dozen of the neglected smaller moons. Some of these had never even been properly surveyed, much less visited.

As soon as he heard of the mission, Rolf van der Berg called the Tsung shipping agent and made some discreet enquiries.

'Yes, first we'll head in towards Io - then do a flyby of Europa -'

'Only a flyby? How close?'

'Just a moment - odd, the flight plan doesn't give details. But of course she won't go inside the Interdiction Zone.'

'Which was down to ten thousand kilometres at the last ruling... fifteen years ago. Anyway, I'd like to volunteer as Mission Planetologist. I'll send across my qualifications -'

'No need to do so, Dr van der Berg. They've already asked for you.'

It is always easy to be wise after the event, and when he cast his mind back (he had plenty of time for it later) Captain Laplace recalled a number of curious aspects of the charter. Two crew members were taken suddenly sick, and were replaced at short notice; he was so glad to have substitutes that he did not check their papers as closely as he might have done. (And even if he had, he would have discovered that they were perfectly in order.)

Then there was the trouble with the cargo. As captain, he was entitled to inspect anything that went aboard the ship. Of course, it was impossible to do this for every item, but he never hesitated to investigate if he had good reason. Space crews were, on the whole, a highly responsible body of men; but long missions could be boring, and there were tedium-relieving chemicals which - though perfectly legal on Earth - should be discouraged off it.

When Second Officer Chris Floyd reported his suspicions, the Captain assumed that the ship's chromatographic 'sniffer' had detected another cache of the high-grade opium which his largely Chinese crew occasionally patronized. This time, however, the matter was serious - very serious.

'Cargo Hold Three, Item 2/456, Captain. The manifest says "Scientific apparatus". It contains explosives.'

'What!'

'Definitely, Sir. Here's the electrogram.'

'I'll take your word for it, Mr Floyd. Have you inspected the item?'

'No, Sir. It's in a sealed crew case, half a metre by one metre by five metres, approximately. One of the largest packages the science team brought aboard. It's labelled FRAGILE - HANDLE WITH CARE. But so is everything, of course.'

Captain Laplace drummed his fingers thoughtfully on the grained plastic 'wood' of his desk. (He hated the pattern, and intended to get rid of it on the next refit.) Even that slight action started him rising out of his seat, and he automatically anchored himself by wrapping his foot around the pillar of the chair.

Though he did not for a moment doubt Floyd's report - his new Second Officer was very competent, and the Captain was pleased that he had never brought up the subject of his famous grandfather -there could be an innocent explanation. The sniffer might have been misled by other chemicals with nervous molecular bondings.

They could go down into the hold and force open the package. No - that might be dangerous, and could cause legal problems as well. Best to go straight to the top; he'd have to do that anyway, sooner or later.

'Please bring Dr Anderson here - and don't mention this to anyone else.'

'Very good, Sir.' Chris Floyd gave a respectful but quite unnecessary salute, and left the room in a smooth, effortless glide.

The leader of the science team was not accustomed to zero gravity, and his entrance was quite clumsy. His obvious genuine indignation did not help, and he had to grab the Captain's desk several times in an undignified manner.

'Explosives! Of course not! Let me see the manifest... 2/456...'

Dr Anderson pecked out the reference on his portable keyboard, and slowly read off: "Mark V penetrometers, Quantity three." Of course - no problem.'

'And just what,' said the Captain, 'is a penetrometer?' Despite his concern, he had difficulty in suppressing a smile; it sounded a little obscene.

'Standard planetary sampling device. You drop it, and with any luck it will give you a core up to ten metres long - even in hard rock. Then it sends back a complete chemical analysis. The only safe way to study places like dayside Mercury - or Io, where we'll drop the first one.'

'Dr Anderson,' said the Captain, with great selfrestraint, 'you may be an excellent geologist, but you don't know much about celestial mechanics. You can't just drop things from orbit -'

The charge of ignorance was clearly unfounded, as the scientist's reaction proved.

'The idiots!' he said. 'Of course, you should have been notified.'

'Exactly. Solid fuel rockets are classified as "Hazardous Cargo". I want clearance from the underwriters, and your personal assurance that the safety systems are adequate; otherwise, they go overboard. Now, any other little surprises? Were you planning seismic surveys? I believe those usually involve explosives...'

A few hours later, the somewhat chastened scientist admitted that he had also found two bottles of elemental fluorine, used to power the lasers which could zap passing celestial bodies at thousand-kilometre ranges for spectrographic sampling. As pure fluorine was about the most vicious substance known to man, it was high on the list of prohibited materials - but, like the rockets which drove the penetrometers down to their targets, it was essential for the mission.

When he was quite satisfied that all the necessary precautions had been taken, Captain Laplace accepted the scientist's apologies, and his assurance that the oversight was entirely due to the haste with which the expedition had been organized.

He felt sure that Dr Anderson was telling the truth, but already he felt that there was something odd about the mission.

Just how odd he could never have imagined.

23

Inferno

Before the detonation of Jupiter, Io had been second only to Venus as the best approximation to Hell in the Solar System. Now that Lucifer had raised its surface temperature another couple of hundred degrees, even Venus could no longer compete.

The sulphur volcanoes and geysers had multiplied their activity, now reshaping the features of the tormented satellite in years rather than decades. The planetologists had given up any attempt at mapmaking, and contented themselves with taking orbital photographs every few days. From these, they had constructed awe-inspiring time-lapse movies of inferno in action.

Lloyd's of London had charged a stiff premium for this leg of the mission, but Io posed no real danger to a ship doing a flyby at a minimum range of ten thousand kilometres - and over the relatively quiescent nightside at that.

As he watched the approaching yellow and orange globe - the most improbably garish object in the entire Solar System - Second Officer Chris Floyd could not help recalling the time, now half a century ago, when his grandfather had come this way. Here, Leonov had made its rendezvous with the abandoned Discovery, and here Dr Chandra had reawakened the dormant computer Hal. Then both ships had flown on to survey the enormous black monolith hovering at L1, the Inner Lagrange Point between Io and Jupiter.

Now the monolith was gone - and so was Jupiter. The minisun that had risen like a phoenix from the implosion of the giant planet had turned its satellites into what was virtually another Solar System, though only on Ganymede and Europa were there regions with Earthlike temperatures. How long that would continue to be the case, no-one knew. Estimates of Lucifer's life-span ranged from a thousand to a million years.

Galaxy's science team looked wistfully at the L1 point, but it was now far too dangerous to approach. There had always been a river of electrical energy - the Io 'flux tube' - flowing between Jupiter and its inner satellite, and the creation of Lucifer had increased its strength several hundredfold. Sometimes the river of power could even be seen by the naked eye, glowing yellow with the characteristic light of ionized sodium. Some

engineers on Ganymede had talked hopefully about tapping the gigawatts going to waste next door, but no-one could think of a plausible way of doing so.

The first penetrometer was launched, with vulgar comments from the crew, and two hours later drove like a hypodermic needle into the festering satellite. It continued to operate for almost five seconds - ten times its designed lifetime - broadcasting thousands of chemical, physical and rheological measurements, before Io demolished it.

The scientists were ecstatic; van der Berg was merely pleased. He had expected the probe to work; Io was an absurdly easy target. But if he was right about Europa, the second penetrometer would surely fail.

Yet that would prove nothing; it might fail for a dozen good reasons. And when it did, there would be no alternative but a landing.

Which, of course, was totally prohibited - not only by the laws of man.

24

Shaka the Great

ASTROPOL - which, despite its grandiose title, had disappointingly little business off Earth - would not admit that SHAKA really existed. The USSA took exactly the same position, and its diplomats became embarrassed or indignant when anyone was tactless enough to mention the name.

But Newton's Third Law applies in politics, as in everything else. The Bund had its extremists - though it tried, sometimes not very hard, to disown them - continually plotting against the USSA. Usually they

confined themselves to attempts at commercial sabotage, but there were occasional explosions, disappearances and even assassinations.

Needless to say, the South Africans did not take this lightly. They reacted by establishing their own official counter-intelligence services, which also had a rather free-wheeling range of operations - and likewise claimed to know nothing about SHAKA. Perhaps they were employing the useful CIA invention of 'plausible deniability'. It is even possible that they were telling the truth.

According to one theory, SHAKA started as a codeword, and then - rather like Prokofiev's 'Lieutenant Kije' - had acquired a life of its own, because it was useful to various clandestine bureaucracies. This would certainly account for the fact that none of its members had ever defected, or even been arrested.

But there was another, somewhat far-fetched explanation for this, according to those who believed that SHAKA really did exist. All its agents had been psychologically conditioned to self-destruct before there was any possibility of interrogation.

Whatever the truth, no-one could seriously imagine that, more than two centuries after his death, the legend of the great Zulu tyrant would cast its shadow across worlds he never knew.

During the decade after the ignition of Jupiter, and the spreading of the Great Thaw across its satellite system, Europa had been left strictly alone. Then the Chinese had made a swift flyby, probing the clouds with radar in

an attempt to locate the wreck of the Tsien. They had been unsuccessful, but their maps of dayside were the first to show the new continents now emerging as the ice-cover melted.

They had also discovered a perfectly straight two-kilometre-long feature which looked so artificial that it was christened the Great Wall. Because of its shape and size it was assumed to be the Monolith -or a monolith, since millions had been replicated in the hours before the creation of Lucifer.

However, there had been no reaction, or any hint of an intelligent signal, from below the steadily thickening clouds. So a few years later, survey satellites were placed in permanent orbit, and high-altitude balloons were dropped into the atmosphere to study its wind patterns. Terrestrial meteorologists found these of absorbing interest, because Europa - with a central ocean, and a sun that never set - presented a beautifully simplified model for their text-books.

So had begun the game of 'European Roulette', as the administrators were fond of calling it whenever the scientists proposed getting closer to the satellite.

After fifty uneventful years, it had become somewhat boring. Captain Laplace hoped it would remain that way, and had required considerable reassurance from Dr Anderson.

'Personally,' he had told the scientist, 'I would regard it as a slightly unfriendly act, to have a ton of armour-piercing hardware dropped on me at a thousand kilometres an hour. I'm quite surprised the World Council gave you permission.'

Dr Anderson was also a little surprised, though he might not have been had he known that the project was the last item on a long agenda of a Science SubCommittee late on a Friday afternoon. Of such trifles history is made.

'I agree, Captain. But we are operating under very strict limitations, and there's no possibility of interfering with the - ah - Europeans, whoever they are. We're aiming at a target five kilometres above sea level.'

'So I understand. What's so interesting about Mount Zeus?'

'It's a total mystery. It wasn't even there, only a few years ago. So you can understand why it drives the geologists crazy.'

'And your gadget will analyse it when it goes in.'

'Exactly. And - I really shouldn't be telling you this - but I've been asked to keep the results confidential, and to send them back to Earth encrypted. Obviously, someone's on the track of a major discovery, and wants to make quite sure they're not beaten to a publication. Would you believe that scientists could be so petty?'

Captain Laplace could well believe it, but did not want to disillusion his passenger. Dr Anderson seemed touchingly naïve; whatever was going on - and the Captain was now quite certain there was much more to this mission than met the eye - Anderson knew nothing about it.

'I can only hope, Doctor, that the Europeans don't go in for mountain climbing. I'd hate to interrupt any attempt to put a flag on their local Everest.'

There was a feeling of unusual excitement aboard Galaxy when the penetrometer was launched - and even the inevitable jokes were muted. During the two hours of the probe's long fall towards Europa, virtually every member of the crew found some perfectly legitimate excuse to visit the bridge and watch the guidance operation. Fifteen minutes before impact, Captain Laplace declared it out of bounds to all visitors, except the

ship's new steward Rosie; without her endless supply of squeezebulbs full of excellent coffee, the operation could not have continued.

Everything went perfectly. Soon after atmospheric entry, the air-brakes were deployed, slowing the penetrometer to an acceptable impact velocity. The radar image of the target - featureless, with no indication of scale - grew steadily on the screen. At minus one second, all the recorders switched automatically to high speed...

But there was nothing to record. 'Now I know,' said Dr Anderson sadly, 'just how they felt at the Jet Propulsion Lab, when those first Rangers crashed into the Moon - with their cameras blind.'

26

Night Watch

Only time is universal; night and day are merely quaint local customs, found on those planets which tidal forces have not yet robbed of their rotation. But however far they travel from their native world, human beings can never escape the diurnal rhythm, set ages ago by its cycle of light and darkness.

So at 01.05, Universal Time, Second Officer Chang was alone on the bridge, while the ship was sleeping around him. There was no real need for him to be awake either, since Galaxy's electronic senses would detect any malfunction far sooner than he could possibly do. But a century of cybernetics had proved that human beings were still slightly better than machines at dealing with the unexpected; and sooner or later, the unexpected always happened.

'Where's my coffee?' thought Chang grumpily. 'It's not like Rosie to be late.' He wondered if the steward had been affected by the same malaise that had overtaken both scientists and space crew, after the disasters of the last twenty-four hours.

Following the failure of the first penetrometer, there had been a hasty conference to decide the next step. One unit was left; it had been intended for Callisto, but it could be used just as easily here.

'And anyway,' Dr Anderson had argued, 'we've landed on Callisto - there's nothing there except assorted varieties of cracked ice.'

There had been no disagreement. After a twelve-hour delay for modification and testing, Pen No. 3 was launched into the European cloudscape, following the invisible track of its precursor.

This time, the ship's recorders did get some data - for about half a millisecond. The accelerometer on the probe, which was calibrated to operate up to 20,000 gee, gave one brief pulse before going off-scale. Everything must have been destroyed in very much less than the twinkling of an eye.

After a second, and even gloomier, post-mortem, it was decided to report to Earth, and wait in high orbit round Europa for any further instructions, before proceeding to Callisto and the outer moons,

'Sorry to be late, Sir,' said Rose McCullen (one would never guess from her name that she was slightly darker than the coffee she was carrying) 'but I must have set the alarm wrong.'

'Lucky for us,' chuckled the Officer of the Watch, 'that you're not running the ship.'

'I don't understand how anyone could run it,' answered Rose. 'It all looks so complicated.'

'Oh, it's not as bad as it looks,' said Chang. 'And don't they give you basic space theory in your training course?'

'Er - yes. But I never understood much of it. Orbits and all that nonsense.'

Second Officer Chang was bored, and felt it would be a kindness to enlighten his audience. And although Rose was not exactly his type, she was undoubtedly attractive; a little effort now might be a worthwhile investment. It never occurred to him that, having performed her duty, Rose might like to go back to sleep.

Twenty minutes later, Second Officer Chang waved at the navigation console and concluded expansively: 'So you see, it's really almost automatic. You only have to punch in a few numbers and the ship takes care of the rest.'

Rose seemed to be getting tired; she kept looking at her watch.

'I'm sorry,' said the suddenly contrite Chang. 'I shouldn't have kept you up.'

'Oh no - it's extremely interesting. Please go on.'

'Definitely not. Maybe some other time. Goodnight, Rosie - and thanks for the coffee.'

'Goodnight, Sir.'

Steward Third Class Rose McCullen glided (not too skilfully) towards the still open door. Chang did not bother to look back when he heard it close.

It was thus a considerable shock when, a few seconds later, he was addressed by a completely unfamiliar female voice.

'Mr Chang - don't bother to touch the alarm button - it's disconnected. Here are the landing coordinates. Take the ship down.'

Slowly, wondering if he had somehow dozed off and was having a nightmare, Chang rotated his chair.

The person who had been Rose McCullen was floating beside the oval hatchway, steadying herself by holding on to the locking lever of the door. Everything about her seemed to have changed; in a moment of time, their roles had been reversed. The shy steward - who had never before looked at him directly - was now regarding Chang with a cold, merciless stare that made him feel like a rabbit hypnotized by a snake. The small but deadly-looking gun nestling in her free hand seemed an unnecessary adornment; Chang had not the slightest doubt that she could very efficiently kill him without it.

Nevertheless, both his self-respect and his professional honour demanded that he should not surrender without some sort of a struggle. At the very least, he might be able to gain time.

'Rose,' he said - and now his lips had difficulty in forming a name which had become suddenly inappropriate - 'this is perfectly ridiculous. What I told you just now - it's simply not true. I couldn't possibly land the ship by myself. It would take hours to compute the correct orbit, and I'd need someone to help me. A co-pilot, at least.'

The gun did not waver.

'I'm not a fool, Mr Chang. This ship isn't energy-limited, like the old chemical rockets. The escape velocity of Europa is only three kilometres a second. Part of your training is an emergency landing with the main computer down. Now you can put it into practice: the window for an

optimum touchdown at the coordinates I will give you opens in five minutes.'

'That type of abort,' said Chang, now beginning to sweat profusely, 'has an estimated twenty-five per cent failure rate' - the true figure was ten per cent, but in the circumstances he felt that a little exaggeration was justified - 'and it's years since I checked out on it.'

'In that case,' answered Rose McCullen, 'I'll have to eliminate you and ask the Captain to send me someone more qualified. Annoying, because we'll miss this window and have to wait a couple of hours for the next one. Four minutes left.'

Second Officer Chang knew when he was beaten; but at least he had tried.

'Let me have those coordinates,' he said.

27

Rosie

Captain Laplace woke instantly at the first gentle tapping, like a distant woodpecker, of the attitude control jets. For a moment he wondered if he was dreaming: no, the ship was definitely turning in space.

Perhaps it was getting too hot on one side and the thermal control system was making some minor adjustments. That did happen occasionally, and was a black mark for the officer on duty, who should have noticed that the temperature envelope was being approached.

He reached for the intercom button to call - who was it? - Mr Chang on the bridge. His hand never completed the movement.

After days of weightlessness, even a tenth of a gravity is a shock. To the Captain it seemed like minutes, though it must have been only a few seconds, before he could unbuckle his restraining harness and struggle out of his bunk. This time, he found the button and jabbed it viciously. There was no reply.

He tried to ignore the thuds and bumps of inadequately secured objects that had been taken unawares by the onset of gravity. Things seemed to go on falling for a long time, but presently the only abnormal sound was the muffled, far-off scream of the drive at full blast.

He tore open the curtain of the cabin's little window, and looked out at the stars. He knew roughly where the ship's axis should have been pointing; even if he could only judge it to within thirty or forty degrees, that would allow him to distinguish between the two possible alternatives.

Galaxy could be vectored either to gain, or to lose, orbital velocity. It was losing it - and therefore preparing to fall towards Europa.

There was an insistent banging on the door, and the Captain realized that little more than a minute could really have passed. Second Officer Floyd and two other crew members were crowded in the narrow passageway.

'The bridge is locked, Sir,' Floyd reported breathlessly. 'We can't get in - and Chang doesn't answer. We don't know what's happened.'

'I'm afraid I do,' Captain Laplace answered, climbing into his shorts. 'Some madman was bound to try it sooner or later. We've been hijacked, and I know where. But I'm damned if I know why.'

He glanced at his watch, and did a quick mental calculation.

'At this thrust level, we'll have deorbited within fifteen minutes - make it ten for safety. Any way we can cut the drive without endangering the ship?'

Second Officer Yu, Engineering, looked very unhappy, but volunteered a reluctant reply.

'We could pull the circuit breakers in the pump motor lines, and cut off the propellant supply.'

'Can we get at them?'

'Yes - they're on Deck Three.'

'Then let's go.'

'Er - then the independent backup system would take over. For safety, that's behind a sealed bulkhead on Deck Five - we'd have to get a cutter - no, it couldn't be done in time.'

Captain Laplace had been afraid of that. The men of genius who had designed Galaxy had tried to protect the ship from all plausible accidents. There was no way they could have safeguarded it against human malevolence.

'Any alternatives?'

'Not in the time available, I'm afraid.'

'Then let's get to the bridge and see if we can talk to Chang - and whoever is with him.'

And who could that be? he wondered. He refused to believe that it could be one of his regular crew. That left - of course, there was the answer! He

could see it all. Monomaniac researcher tries to prove theory - experiments frustrated - decides that the quest for knowledge takes precedence over everything else.

It was uncomfortably like one of those cheap 'mad scientist' melodramas, but it fitted the facts perfectly. He wondered if Dr Anderson had decided that this was the only road to a Nobel Prize.

That theory was swiftly demolished when the breathless and dishevelled geologist arrived gasping:

'For God's sake, Captain - what's happening? We're under full thrust! Are we going up - or down?'

'Down,' answered Captain Laplace. 'In about ten minutes, we'll be in an orbit that will hit Europa. I can only hope that whoever's at the controls knows what he's doing.'

Now they were at the bridge, facing the closed door. Not a sound came from the far side.

Laplace rapped as loudly as he possibly could without bruising his knuckles.

'This is the Captain! Let us in!'

He felt rather foolish at giving an order which would certainly be ignored, but he hoped for at least some reaction. To his surprise, he got one.

The external speaker hissed into life, and a voice said: 'Don't attempt anything foolish, Captain. I have a gun, and Mr Chang is obeying my orders.'

'Who was that?' whispered one of the officers. 'It sounds like a woman!'

'You're right,' said the Captain grimly. That certainly cut down the alternatives, but didn't help matters in any way.

'What do you hope to do? You know you can't possibly get away with it!' he shouted, trying to sound masterful rather than plaintive.

'We're landing on Europa. And if you want to take off again, don't try to stop me.'

'Her room's completely clean,' Second Officer Chris Floyd reported thirty minutes later, when the thrust had been cut to zero and Galaxy was falling along the ellipse which would soon graze the atmosphere of Europa. They were now committed; although it would now be possible to immobilize the engines, it would be suicide to do so. They would be needed again to make a landing - although that could be merely a more protracted form of suicide.

'Rosie McCullen! Who would have believed it! Do you suppose she's on drugs?'

'No,' said Floyd. 'This has been very carefully planned. She must have a radio hidden somewhere in the ship. We should search for it.'

'You sound like a damned cop.'

'That will do, gentlemen,' said the Captain. Tempers were getting frayed, largely through sheer frustration and the total failure to establish any further contact with the barricaded bridge. He glanced at his watch.

'Less than two hours before we enter atmosphere - what there is of it. I'll be in my cabin - it's just possible they may try to call me there. Mr Yu, please stand by the bridge and report any developments at once.'

He had never felt so helpless in his life, but there were times when doing nothing was the only thing to do. As he left the officers' wardroom, he heard someone say wistfully: 'I could do with a bulb of coffee. Rosie made the best I've ever tasted.'

Yes, thought the Captain grimly, she's certainly efficient. Whatever job she tackles, she'll do it thoroughly.

28

Dialogue

There was only one man aboard Galaxy who could regard the situation as anything but a total disaster. I may be about to die, Rolf van der Berg told himself; but at least I have a chance of scientific immortality. Though that might be poor consolation, it was more than anyone else on the ship could hope for.

That Galaxy was heading for Mount Zeus he did not doubt for a moment; there was nothing else on Europa of any significance. Indeed, there was nothing remotely comparable on any planet.

So his theory - and he had to admit that it was still a theory - was no longer a secret. How could it have leaked out?

He trusted Uncle Paul implicitly, but he might have been indiscreet. More likely, someone had monitored his computers, perhaps as a matter of routine. If so, the old scientist could well be in danger; Rolf wondered if he could - or should - get a warning to him. He knew that the communications officer was trying to contact Ganymede via one of the emergency transmitters; an automatic beacon alert had already gone out,

and the news would be hitting Earth any minute now. It had been on its way now for almost an hour...

'Come in,' he said, at the quiet knock on his cabin door. 'Oh - hello, Chris. What can I do for you?'

He was surprised to see Second Officer Chris Floyd, whom he knew no better than any of his other colleagues. If they landed safely on Europa, he thought gloomily, they might get to know each other far better than they wished.

'Hello, Doctor. You're the only person who lives around here. I wondered if you could help me.'

'I'm not sure how anyone can help anyone at the moment. What's the latest from the bridge?'

'Nothing new: I've just left Yu and Gillings up there, trying to fix a mike on the door. But no-one inside seems to be talking; not surprising - Chang must have his hands full.'

'Can he get us down safely?'

'He's the best; if anyone can do it, he can. I'm more worried about getting off again.'

'God - I'd not been looking that far ahead. I assumed that was no problem.'

'It could be marginal. Remember, this ship is designed for orbital operations. We hadn't planned to put down on any major moon - though we had hoped to rendezvous with Ananke and Carme. So we could be stuck on Europa - especially if Chang has to waste propellant looking for a good landing site.'

'Do we know where he is trying to land?' Rolf asked, trying not to sound more interested than might be reasonably expected. He must have failed, because Chris looked at him sharply.

'There's no way we can tell at this stage, though we may get a better idea when he starts braking. But you know these moons; where do you think?'

'There's only one interesting place. Mount Zeus.'

'Why should anyone want to land there?'

Rolf shrugged.

'That was one of the things we'd hoped to find out. Cost us two expensive penetrometers.'

'And it looks like costing a great deal more. Haven't you any ideas?'

'You sound like a cop,' said van der Berg with a grin, not intending it in the least seriously.

'Funny - that's the second time I've been told that in the last hour.'

Instantly, there was a subtle change in the atmosphere of the cabin - almost as if the life-support system had readjusted itself.

'Oh - I was just joking - are you?'

'If I was, I wouldn't admit it, would I?'

That was no answer, thought van der Berg; but on second thoughts, perhaps it was.

He looked intently at the young officer, noticing - not for the first time - his striking resemblance to his famous grandfather. Someone had mentioned that Chris Floyd had only joined Galaxy on this mission, from another ship in the Tsung fleet - adding sarcastically that it was useful to have good connections in any business. But there had been no criticism of Floyd's ability; he was an excellent space officer. Those skills might qualify him for other part-time jobs as well; look at RosieMcCullen - who had also, now he came to think of it, joined Galaxy just before this mission.

Rolf van der Berg felt that he had become enmeshed in some vast and tenuous web of interplanetary intrigue; as a scientist, accustomed to getting - usually - straightforward answers to the questions he put to nature, he did not enjoy the situation.

But he could hardly claim to be an innocent victim. He had tried to conceal the truth - or at least what he believed to be the truth. And now the consequences of that deceit had multiplied like the neutrons in a chain reaction; with results that might be equally disastrous.

Which side was Chris Floyd on? How many sides were there? The Bund would certainly be involved, once the secret had leaked out. But there were splinter groups within the Bund itself, and groups opposing them; it was like a hall of mirrors.

There was one point, however, on which he did feel reasonably certain. Chris Floyd, if only because of his connections, could be trusted. I'd put my money, thought van der Berg, on him being assigned to ASTROPOL for the duration of the mission - however long, or short, that might now be.

'I'd like to help you, Chris,' he said slowly. 'As you probably suspect, I do have some theories. But they may still be utter nonsense.'

'In less than half an hour, we may know the truth. Until then, I prefer to say nothing.'

And this is not, he told himself, merely ingrained Boer stubbornness. If he had been mistaken, he would prefer not to die among men who knew that he was the fool who had brought them to their doom.

29

Descent

Second Officer Chang had been wrestling with the problem ever since Galaxy had been successfully - to his surprise as much as his relief - injected into transfer orbit. For the next couple of hours she was in the hands of God, or at least Sir Isaac Newton; there was nothing to do but wait until the final braking and descent manoeuvre.

He had briefly considered trying to fool Rosie by giving the ship a reverse vector at closest approach, and so taking it out into space again. It would then be back in a stable orbit, and a rescue could eventually be mounted from Ganymede. But there was a fundamental objection to this scheme: he would certainly not be alive to be rescued. Though Chang was no coward, he would prefer not to become a posthumous hero of the spaceways.

In any event, his chances of surviving the next hour seemed remote. He had been ordered to take down, single-handed, a three-thousand tonner on totally unknown territory. This was not a feat he would care to attempt even on the familiar Moon.

'How many minutes before you start braking?' asked Rosie. Perhaps it was more of an order than a question; she clearly understood the

fundamentals of astronautics, and Chang abandoned his last wild fantasies of outwitting her.

'Five,' he said reluctantly. 'Can I warn the rest of the ship to stand by?'

'I'll do it. Give me the mike... THIS IS THE BRIDGE. WE START BRAKING IN FIVE MINUTES. REPEAT, FIVE MINUTES. OUT.'

To the scientists and officers assembled in the wardroom, the message was fully expected. They had had one piece of luck; the external video monitors had not been switched off. Perhaps Rose had forgotten about them; it was more likely that she had not bothered. So now, as helpless spectators - quite literally, a captive audience - they could watch their unfolding doom.

The cloudy crescent of Europa now filled the field of the rear-view camera. There was no break anywhere in the solid overcast of water vapour recondensing on its way back to nightside. That was not important, since the landing would be radar-controlled until the last moment. It would, however, prolong the agony of observers who had to rely on visible light,

No-one stared more intently at the approaching world than the man who had studied it with such frustration for almost a decade. Rolf van der Berg, seated in one of the flimsy low-gravity chairs with the restraining belt lightly fastened, barely noticed the first onset of weight as braking commenced.

In five seconds, they were up to full thrust. All the officers were doing rapid calculations on their comsets; without access to Navigation, there would be a lot of guesswork, and Captain Laplace waited for a consensus to emerge.

'Eleven minutes,' he announced presently, 'assuming he doesn't reduce thrust level - he's at max now. And assuming he's going to hover at ten

kilometres - just above the overcast - and then go straight down. That could take another five minutes.'

It was unnecessary for him to add that the last second of those five minutes would be the most critical.

Europa seemed determined to keep its secrets to the very end. When Galaxy was hovering motionless, just above the cloudscape, there was still no sign of the land - or sea - beneath. Then, for a few agonizing seconds, the screens became completely blank - except for a glimpse of the now extended, and very seldom used, landing gear. The noise of its emergence a few minutes earlier had caused a brief flurry of alarm among the passengers; now they could only hope that it would perform its duty.

How thick is this damn cloud? van der Berg asked himself. Does it go all the way down - No, it was breaking, thinning out into shreds and wisps - and there was the new Europa, spread out, it seemed, only a few thousand metres below.

It was indeed new; one did not have to be a geologist to see that. Four billion years ago, perhaps, the infant Earth had looked like this, as land and sea prepared to begin their endless conflict.

Here, until fifty years ago, there had been neither land nor sea - only ice. But now the ice had melted on the Lucifer-facing hemisphere, the resulting water had boiled upwards - and been deposited in the permanent deep-freeze of nightside. The removal of billions of tons of liquid from one hemisphere to the other had thus exposed ancient seabeds that had never before known even the pale light of the far-distant Sun.

Some day, perhaps, these contorted landscapes would be softened and tamed by a spreading blanket of vegetation; now they were barren lava flows and gently steaming mud flats, interrupted occasionally by masses of up-thrust rock with strangely slanting strata. This had clearly been an

area of great tectonic disturbance, which was hardly surprising if it had seen the recent birth of a mountain the size of Everest.

And there it was - looming up over the unnaturally close horizon. Rolf van der Berg felt a tightness in his chest, and a tingling of the flesh at the back of his neck. No longer through the remote impersonal senses of instruments, but with his own eyes, he was seeing the mountain of his dreams.

As he well knew, it was in the approximate shape of a tetrahedron, tilted so that one face was almost vertical. (That would be a nice challenge to climbers, even in this gravity - especially as they couldn't drive pitons into it...) The summit was hidden in the clouds, and much of the gently-sloping face turned towards them was covered with snow.

'Is that what all the fuss is about?' muttered someone in disgust. 'Looks like a perfectly ordinary mountain to me. I guess that once you've seen one -' He was 'shushed' angrily into silence.

Galaxy was now drifting slowly towards Mount Zeus, as Chang searched for a good landing place. The ship had very little lateral control, as ninety per cent of the main thrust had to be used merely to support it. There was enough propellant to hover for perhaps five minutes; after that, he might still be able to land safely - but he could never take off again.

Neil Armstrong had faced the same dilemma, almost a hundred years ago. But he had not been piloting with a gun aimed at his head.

Yet for the last few minutes, Chang had totally forgotten both gun and Rosie. Every sense was focused on the job ahead; he was virtually part of the great machine he was controlling. The only human emotion left to him was not fear - but exhilaration. This was the job he had been trained to perform; this was the highlight of his professional career - even as it might be the finale.

And that was what it looked like becoming. The foot of the mountain was now less than a kilometre away - and he had still found no landing site. The terrain was incredibly rugged, torn with canyons, littered with gigantic boulders. He had not seen a single horizontal area larger than a tennis court -and the red line on the propellant gauge was only thirty seconds away.

But there, at last, was a smooth surface - much the flattest he'd seen - it was his only chance within the time frame.

Delicately, he juggled the giant, unstable cylinder he was controlling towards the patch of horizontal ground - it seemed to be snow-covered - yes, it was - the blast was blowing the snow away - but what's underneath? - looks like ice - must be a frozen lake - how thick? - HOW THICK? -The five-hundred-ton hammer-blow of Galaxy's main jets hit the treacherously inviting surface. A pattern of radiating lines sped swiftly across it; the ice cracked, and great sheets started to overturn. Concentric waves of boiling water hurtled outwards as the fury of the drive blasted into the suddenly uncovered lake.

Like the well-trained officer he was, Chang reacted automatically, without the fatal hesitations of thought. His left hand ripped open the SAFETY LOCK bar; his right grabbed the red lever it protected - and pulled it to the open position.

The ABORT program, peacefully sleeping ever since Galaxy was launched, took over and hurled the ship back up into the sky.

In the wardroom, the sudden surge of full thrust came like a stay of execution. The horrified officers had seen the collapse of the chosen landing site, and knew that there was only one way of escape. Now that Chang had taken it, they once more permitted themselves the luxury of breath.

But how long they could continue to enjoy that experience, no-one could guess. Only Chang knew whether the ship had enough propellant to reach a stable orbit; and even if it did, Captain Laplace thought gloomily, the lunatic with the gun might order him down again. Though he did not for a minute believe that she really was a lunatic; she knew exactly what she was doing.

Suddenly, there was a change in thrust.

'Number Four motor's just cut,' said an engineering officer. 'I'm not surprised - probably overheated. Not rated for so long at this level.'

There was, of course, no sense of any directional change - the reduced thrust was still along the ship's axis - but the views on the monitor screens had tilted crazily. Galaxy was still ascending, but no longer vertically. She had become a ballistic missile, aimed at some unknown target on Europa.

Once more, the thrust dropped abruptly; across the video monitors, the horizon became level again.

'He's cut the opposite motor - only way to stop us cartwheeling - but can he maintain altitude - good man!'

The watching scientists could not see what was good about it; the view on the monitors had disappeared completely, obscured by a blinding white fog.

'He's dumping excess propellant - lightening the ship -'

The thrust dwindled away to zero; the ship was in free fall. In a few seconds, it had dropped through the vast cloud of ice crystals created when its dumped propellant had exploded into space. And there beneath it, approaching at a leisurely one-eighth of a gravity acceleration, was Europa's central sea. At least Chang would not have to select a landing site; from now on, it would be standard operating procedure, familiar as a video game to millions who had never gone into space, and never would.

All you had to do was to balance the thrust against gravity, so that the descending ship reached zero velocity at zero altitude. There was some margin for error, but not much, even for the water landings which the first American astronauts had preferred, and which Chang was now reluctantly emulating. If he made a mistake - and after the last few hours, he could scarcely be blamed - no home computer would say to him: 'Sorry - you've crashed. Would you like to try again? Answer YES/NO...'

Second Officer Yu and his two companions, waiting with their improvised weapons outside the locked door of the bridge, had perhaps been given the toughest assignment of all. They had no monitor screens to tell them what was happening, and had to rely on messages from the wardroom. Nor had there been anything through the spy mike, which was hardly surprising. Chang and McCullen had very little time or need for conversation.

The touchdown was superb, with hardly a jolt. Galaxy sank a few extra metres, then bobbed up again, to float vertically and - thanks to the weight of the engines - in the upright position.

It was then that the listeners heard the first intelligible sounds through the spy mike.

'You maniac, Rosie,' said Chang's voice, more in resigned exhaustion than anger. 'I hope you're satisfied. You've killed us all.'

There was one pistol shot, then a long silence.

Yu and his colleagues waited patiently, knowing that something was bound to happen soon. Then they heard the locking levers being unlatched, and gripped the spanners and metal bars they were carrying. She might get one of them, but not all -The door swung open, very slowly.

'Sorry,' said Second Officer Chang. 'I must have passed out for a minute.'

Then, like any reasonable man, he fainted again.

31

The Sea of Galilee

I can never understand how a man could become a doctor, Captain Laplace told himself. Or an undertaker, for that matter. They have some nasty jobs to do...

'Well, did you find anything?'

'No, Skipper. Of course, I don't have the right sort of equipment. There are some implants that you could only locate through a microscope - or so I'm told. They could only be very short range, though.'

'Perhaps to a relay transmitter somewhere in the ship - Floyd's suggested we make a search. You took fingerprints and - any other idents?'

'Yes - when we contact Ganymede, we'll beam them up, with her papers. But I doubt if we'll ever know who Rosie was, or who she was acting for. Or why, for God's sake.'

'At least she showed some human instincts,' said Laplace thoughtfully. 'She must have known she'd failed, when Chang pulled the ABORT lever. She could have shot him then, instead of letting him land.'

'Much good that will do us, I'm afraid. Let me tell you something that happened when Jenkins and I put the cadaver out through the refuse dump.'

The doctor pursed his lips in a grimace of distaste.

'You were right, of course - it was the only thing to do. Well, we didn't bother to attach any weights - it floated for a few minutes - we watched to see if it would clear the ship - and then...'

The doctor seemed to be struggling for words.

'What, dammit?'

'Something came up out, of the water, Like a parrot beak, but about a hundred times bigger. It took - Rosie - with one snap, and disappeared. We have some impressive company here; even if we could breathe outside, I certainly wouldn't recommend swimming -'

'Bridge to Captain,' said the officer on duty, 'Big disturbance in the water - camera three - I'll give you the picture.'

'That's the thing I saw!' cried the doctor. He felt a sudden chill at the inevitable, ominous thought: I hope it's not back for more.

Suddenly, a vast bulk broke through the surface of the ocean and arched into the sky. For a moment, the whole monstrous shape was suspended between air and water.

The familiar can be as shocking as the strange - when it is in the wrong place. Both captain and doctor exclaimed simultaneously: 'It's a shark!'

There was just time to notice a few subtle differences - in addition to the monstrous parrot-beak - before the giant crashed back into the sea. There was an extra pair of fins - and there appeared to be no gills. Nor were there any eyes, but on either side of the beak there were curious protuberances that might be some other sense organs.

'Convergent evolution, of course,' said the doctor. 'Same problems, same solutions, on any planet. Look at Earth. Sharks, dolphins, ichthyosaurs - all oceanic predators must have the same basic design. That beak puzzles me, though -'

'What's it doing now?'

The creature had surfaced again, but now it was moving very slowly, as if exhausted after that one gigantic leap. In fact, it seemed to be in trouble - even in agony; it was beating its tail against the sea, without attempting to move in any definite direction.

Suddenly, it vomited its last meal, turned belly up, and lay wallowing lifelessly in the gentle swell.

'Oh my God,' whispered the Captain, his voice full of revulsion. 'I think I know what's happened.'

'Totally alien biochemistries,' said the doctor; even he seemed shaken by the sight. 'Rosie's claimed one victim, after all.'

The Sea of Galilee was, of course, named after the man who had discovered Europa - as he in turn had been named after a much smaller sea on another world.

It was a very young sea, being less than fifty years old; and, like most new-born infants, could be quite boisterous. Although the European atmosphere was still too thin to generate real hurricanes, a steady wind blew from the surrounding land towards the tropical zone at the point above which Lucifer was stationary. Here, at the point of perpetual noon, the water was continually boiling - though at a temperature, in this thin atmosphere, barely hot enough to make a good cup of tea.

Luckily, the steamy, turbulent region immediately beneath Lucifer was a thousand kilometres away; Galaxy had descended in a relatively calm area, less than a hundred kilometres from the nearest land. At peak velocity, she could cover that distance in a fraction of a second; but now, as she drifted beneath the low-hanging clouds of Europa's permanent overcast, land seemed as far-off as the remotest quasar. To make matters worse - if possible - the eternal off-shore wind was taking her further out to sea. And even if she could manage to ground herself on some virgin beach of this new world, she might be no better off than she was now.

But she would be more comfortable; spaceships, though admirably watertight, are seldom seaworthy. Galaxy was floating in a vertical position, bobbing up and down with gentle but disturbing oscillations; half the crew was already sick.

Captain Laplace's first action, after he had been through the damage reports, was to appeal for anyone with experience in handling boats - of any size or shape. It seemed reasonable to suppose that among thirty

astronautical engineers and space scientists there should be a considerable amount of seafaring talent, and he immediately located five amateur sailors and even one professional - Purser Frank Lee who had started his career with the Tsung shipping lines and then switched to space.

Although pursers were more accustomed to handling accounting machines (often, in Frank Lee's case, a two-hundred-year-old ivory abacus) than navigational instruments, they still had to pass exams in basic seamanship. Lee had never had a chance of testing his maritime skills; now, almost a billion kilometres from the South China Sea, his time had come.

'We should flood the propellant tanks,' he told the Captain. 'Then we'll ride lower and won't be bobbing up and down so badly.'

It seemed foolish to let even more water into the ship, and the Captain hesitated.

'Suppose we run aground?'

No one made the obvious comment 'What difference will it make?' Without any serious discussion, it had been assumed that they would be better off on land - if they could ever reach it.

'We can always blow the tanks again. We'll have to do that anyway, when we reach shore, to get the ship into a horizontal position. Thank God we have power...'

His voice trailed off; everyone knew what he meant. Without the auxiliary reactor which was now running the life-support systems, they would all be dead within hours. Now - barring a breakdown - the ship could sustain them indefinitely.

Ultimately, of course, they would starve; they had just had dramatic proof that there was no nourishment, but only poison, in the seas of Europa.

At least they had made contact with Ganymede, so that the entire human race now knew their predicament. The best brains in the Solar System would now be trying to save them. If they failed, the passengers and crew of Galaxy would have the consolation of dying in the full glare of publicity.

IV

**AT THE
WATER
HOLE**

'The latest news,' said Captain Smith to his assembled passengers, 'is that Galaxy is afloat, and in fairly good condition. One crew member - a woman steward - has been killed - we don't know the details - but everyone else is safe.

'The ship's systems are all working; there are a few leaks, but they've been controlled. Captain Laplace says there's no immediate danger, but the prevailing wind is driving them further away from the mainland, towards the centre of dayside. That's not a serious problem - there are several large islands they're virtually certain to reach first. At the moment they're ninety kilometres from the nearest land. They've seen some large marine animals, but they show no sign of hostility.

'Barring further accidents, they should be able to survive for several months, until they run out of food - which of course is now being strictly rationed. But according to Captain Laplace, morale is still high.

'Now, this is where we come in. If we return to Earth immediately, get refuelled and refitted, we can reach Europa in a retrograde, powered orbit in eighty-five days. Universe is the only ship currently commissioned that can land there and take off again with a reasonable payload. The Ganymede shuttles may be able to drop supplies, but that's all - though it may make the difference between life and death.

'I'm sorry, ladies and gentlemen, that our visit has been cut short - but I think you'll agree that we've shown you everything we promised. And I'm sure you'll approve of our new mission - even though the chances of

success are, frankly, rather slim. That's all for the moment. Dr Floyd, can I have a word with you?'

As the others drifted slowly and thoughtfully from the main lounge - scene of so many less portentous briefings - the Captain scanned a clipboard full of messages. There were still occasions when words printed on pieces of paper were the most convenient medium of communication, but even here technology had made its mark. The sheets that the Captain was reading were made of the indefinitely reusable multifax material which had done so much to reduce the load on the humble wastepaper basket.

'Heywood,' he said - now that the formalities were over - 'as you can guess, the circuits are burning up. And there's a lot going on that I don't understand.'

'Ditto,' answered Floyd. 'Anything from Chris yet?'

"No, but Ganymede's relayed your message; he should have had it by now. There's a priority override on private communications, as you can imagine - but of course your name overrode that.'

'Thanks, Skipper. Anything I can do to help?'

'Not really - I'll let you know.'

It was almost the last time, for quite a while, that they would be on speaking terms with each other. Within a few hours Dr Heywood Floyd would become 'That crazy old fool!', and the short-lived 'Mutiny on the Universe' would have begun - led by the Captain.

It was not actually Heywood Floyd's idea; he only wished it was.

Second Officer Roy Jolson was 'Stars', the navigation officer; Floyd barely knew him by sight, and had never had occasion to say more than good morning to him. He was quite surprised, therefore, by the diffident knock on his cabin door.

The astrogator was carrying a set of charts, and seemed a little ill at ease. He could not be overawed by Floyd's presence - everyone on board now took him for granted - so there must be some other reason.

'Dr Floyd,' he began, in a tone of such urgent anxiety that he reminded his listener of a salesman whose entire future depends on making the next deal. 'I'd like your advice - and assistance.'

'Of course - but what can I do?'

Jolson unrolled the chart showing the position of all the planets inside the orbit of Lucifer.

'Your old trick of coupling Leonov and Discovery, to escape from Jupiter before it blew up, gave me the idea.'

'It wasn't mine. Walter Curnow thought of it.'

'Oh - I never knew that. Of course, we don't have another ship to boost us here - but we have something much better.'

'What do you mean?' asked Floyd, completely baffled.

'Don't laugh. Why go back to Earth to take on propellant - when Old Faithful is blasting out tons every second, a couple of hundred metres away? If we tapped that, we could get to Europa not in three months - but in three weeks.'

The concept was so obvious, yet so daring, that it took Floyd's breath away. He could see half a dozen objections instantly; but none of them seemed fatal.

'What does the Captain think of the idea?'

'I've not told him; that's why I need your help. I'd like you to check my calculations - then put the idea to him. He'd turn me down - I'm quite certain - and I don't blame him. If I was captain, I think I would too...'

There was a long silence in the little cabin. Then Heywood Floyd said slowly: 'Let me give you all the reasons why it can't be done. Then you can tell me why I'm wrong.'

Second Officer Jolson knew his commander; Captain Smith had never heard such a crazy suggestion in his life.

His objections were all well-founded, and showed little, if any, trace of the notorious 'not invented here' syndrome.

'Oh, it would work in theory,' he admitted. 'But think of the practical problems, man! How would you get the stuff into the tanks?'

'I've talked to the engineers. We'd move the ship to the edge of the crater - it's quite safe to get within fifty metres. There's plumbing in the unfurnished section we can rip out - then we'd run a line to Old Faithful and wait until he spouts; you know how reliable and well-behaved he is.'

'But our pumps can't operate in a near vacuum!'

'We don't need them; we can rely on the geyser's own efflux velocity to give us an input of at least a hundred kilos a second. Old Faithful will do all the work.'

'He'll just give ice crystals and steam, not liquid water.'

'It will condense when it gets on board.'

'You've really thought this out, haven't you?' said the Captain with grudging admiration. 'But I just don't believe it. Is the water pure enough, for one thing? What about contaminants - especially carbon particles?'

Floyd could not help smiling. Captain Smith was developing an obsession about soot...

'We can filter out large ones; the rest won't affect the reaction. Oh yes - the hydrogen isotope ratio here looks better than for Earth. You may even get some extra thrust.'

'What do your colleagues think of the idea? If we head straight for Lucifer, it may be months before they can get home...

'I've not spoken to them. But does it matter, when so many lives are at stake? We may reach Galaxy seventy days ahead of schedule! Seventy days! Think what could happen on Europa in that time!'

'I'm perfectly aware of the time factor,' snapped the Captain. 'That applies to us as well. We may not have provisions for such an extended trip.'

Now he's straining at gnats, thought Floyd - and he must know that I know it. Better be tactful...

'An extra couple of weeks? I can't believe we have so narrow a margin. You've been feeding us too well, anyway. Do some of us good to be on short rations for a while.'

The Captain managed a frosty smile.

'You can tell that to Willis and Mihailovich. But I'm afraid the whole idea is insane.'

'At least let us try it on the owners. I'd like to speak to Sir Lawrence.'

'I can't stop you, of course,' said Captain Smith, in a tone that suggested he wished he could. 'But I know exactly what he'll say.'

He was quite wrong.

Sir Lawrence Tsung had not placed a bet for thirty years; it was no longer in keeping with his august position in the world of commerce. But as a young man he had often enjoyed a mild flutter at the Hong Kong Race Course, before a puritanical administration had closed it in a fit of public morality. It was typical of life, Sir Lawrence sometimes thought wistfully, that when he could bet he had no money - and now he couldn't, because the richest man in the world had to set a good example.

And yet, as nobody knew better than he did, his whole business career had been one long gamble. He had done his utmost to control the odds, by gathering the best information and listening to the experts his hunches told him would give the wisest advice. He had usually pulled out in time when they were wrong; but there had always been an element of risk.

Now, as he read the memorandum from Heywood Floyd, he felt again the old thrill he had not known since he had watched the horses thundering round into the last lap. Here was a gamble indeed - perhaps the last and greatest of his career - though he would never dare tell his Board of Directors. Still less the Lady Jasmine.

'Bill,' he said, 'what do you think?'

His son (steady and reliable, but lacking that vital spark which was perhaps no longer needed in this generation) gave him the answer he expected.

'The theory is quite sound. Universe can do it - on paper. But we've lost one ship. We'll be risking another.'

'She's going to Jupiter - Lucifer - anyway.'

'Yes - but after a complete checkout in Earth orbit. And do you realize what this proposed direct mission will involve? She'll be smashing all speed records - doing over a thousand kilometres a second at turnaround!'

It was the worst thing he could possibly have said; once again the thunder of hooves sounded in his father's ears.

But Sir Lawrence merely answered: 'It won't do any harm for them to make some tests, though Captain Smith is fighting the idea tooth and nail. Even threatens to resign. Meanwhile, just check the position with Lloyd's - we may have to back down on the Galaxy claim.'

Especially, he might have added, if we're going to throw Universe on to the table, as an even bigger chip.

And he was worried about Captain Smith. Now that Laplace was stranded on Europa, he was the best commander he had left.

'Sloppiest job I've seen since I left college,' grumbled the Chief Engineer. 'But it's the best we can do in the time.'

The makeshift pipeline stretched across fifty metres of dazzling, chemical-encrusted rock to the now quiescent vent of Old Faithful, where it ended in a rectangular, downward-pointing funnel. The sun had just risen over the hills, and already the ground had begun to tremble slightly as the geyser's subterranean - or subhalian - reservoirs felt the first touch of warmth.

Watching from the observation lounge, Heywood Floyd could hardly believe that so much had happened in a mere twenty-four hours. First of all, the ship had split into two rival factions - one led by the Captain, the other perforce headed by himself. They had been coldly polite to each other, and there had been no actual exchange of blows; but he had discovered that in certain quarters he now rejoiced in the nickname of 'Suicide' Floyd. It was not an honour that he particularly appreciated.

Yet no-one could find anything fundamentally wrong with the Floyd-Jolson manoeuvre. (That name was also unfair: he had insisted that Jolson get all the credit, but no-one had listened. And Mihailovich had said: 'Aren't you prepared to share the blame?')

The first test would be in twenty minutes, when Old Faithful, rather belatedly, greeted the dawn. But even if that worked, and the propellant tanks started to fill with sparkling pure water rather than the muddy slurry Captain Smith had predicted, the road to Europa was still not open.

A minor, but not unimportant, factor was the wishes of the distinguished passengers. They had expected to be home within two weeks; now, to their surprise and in some cases consternation, they were faced with the prospect of a dangerous mission halfway across the Solar System - and, even if it succeeded, no firm date for a return to Earth.

Willis was distraught; all his schedules would be totally wrecked. He drifted around muttering about lawsuits, but no-one expressed the slightest sympathy.

Greenburg, on the other hand, was ecstatic; now he would really be in the space business again! And Mihailovich - who spent a lot of time noisily composing in his far from soundproof cabin - was almost equally delighted. He was sure that the diversion would inspire him to new heights of creativity.

Maggie M was philosophical: 'If it can save a lot of lives,' she said, looking pointedly at Willis, 'how can anyone possibly object?'

As for Yva Merlin, Floyd made a special effort to explain matters to her, and discovered that she understood the situation remarkably well. And it was Yva, to his utter astonishment, who asked the question to which no-one else seemed to have paid much attention: 'Suppose the Europeans don't want us to land - even to rescue our friends?'

Floyd looked at her in frank amazement; even now, he still found it difficult to accept her as a real human being, and never knew when she would come out with some brilliant insight or utter stupidity.

'That's a very good question, Yva. Believe me, I'm working on it.'

He was telling the truth; he could never lie to Yva Merlin. That, somehow, would be an act of sacrilege.

The first wisps of vapour were appearing over the mouth of the geyser. They shot upwards and away in their unnatural vacuum trajectories, and evaporated swiftly in the fierce Sunlight.

Old Faithful coughed again, and cleared its throat. A snowy-white - and surprisingly compact - column of ice crystals and water droplets climbed swiftly towards the sky. All one's terrestrial instincts expected it to topple and fall, but of course it did not. It continued onwards and upwards, spreading only slightly, until it merged into the vast, glowing envelope of the comet's still expanding coma. Floyd noted, with satisfaction, that the pipeline was beginning to shake as fluid rushed into it.

Ten minutes later, there was a council of war on the bridge. Captain Smith, still in a huff, acknowledged Floyd's presence with a slight nod; his Number Two, a little embarrassed, did all the talking.

'Well, it works, surprisingly well. At this rate, we can fill our tanks in twenty hours - though we may have to go out and anchor the pipe more securely.'

'What about the dirt?' someone asked.

The First Officer held up a transparent squeeze-bulb holding a colourless liquid.

'The filters got rid of everything down to a few microns, To be on the safe side, we'll run through them twice, cycling from one tank to another. No swimming pool, I'm afraid, until we pass Mars.'

That got a much needed laugh, and even the Captain relaxed a little.

'We'll run up the engines, at minimum thrust, to check that there are no operational anomalies with Halley H2O. If there are, we'll forget the whole idea, and head home on good old Moon water, fob Aristarchus.'

There was one of those 'party silences' where everyone waits simultaneously for someone else to speak. Then Captain Smith broke the embarrassing hiatus.

'As you all know,' he said, 'I'm very unhappy with the whole idea. In fact - ' he changed course abruptly; it was equally well-known that he had considered sending Sir Lawrence his resignation, though in the circumstances that would have been a somewhat pointless gesture.

'But a couple of things have happened in the last few hours. The owner agrees with the project - if no fundamental objections emerge from our tests. And - this is the big surprise, and I don't know any more about it than you do - the World Space Council has not only okayed but requested that we make the diversion, underwriting any expenses incurred. Your guess is as good as mine...

'But I still have one worry -' he looked doubtfully at the little bulb of water, which Heywood Floyd was now holding up to the light and shaking gently. 'I'm an engineer, not a damn chemist. This stuff looks clean - but what will it do to the tank linings?'

Floyd never quite understood why he acted as he did; such rashness was completely uncharacteristic. Perhaps he was simply impatient with the whole debate, and wanted to get on with the job. Or perhaps he felt that the Captain needed a little stiffening of the moral fibre.

With one quick movement, he flicked open the stopcock and squirted approximately 20cc of Halley's Comet down his throat.

'There's your answer, Captain,' he said, when he had finished swallowing.

'And that,' said the ship's doctor half an hour later, 'was one of the silliest exhibitions I've ever seen. Don't you know that there are cyanides and cyanogens and God knows what else in that stuff?'

'Of course, I do,' laughed Floyd. 'I've seen the analyses - just a few parts in a million. Nothing to worry about, But I did have one surprise,' he added ruefully.

'And what was that?'

'If you could ship this stuff back to Earth, you could make a fortune selling it as Halley's Patent Purgative.'

34

Car Wash

Now that they were committed, the whole atmosphere aboard Universe had changed. There was no more argument; everyone was cooperating to the utmost, and very few people had much sleep for the next two rotations of the nucleus - a hundred hours of Earth time.

The first Halley 'day' was devoted to a still rather cautious tapping of Old Faithful, but when the geyser subsided towards nightfall the technique had been thoroughly mastered. More than a thousand tons of water had been taken aboard; the next period of daylight would be ample for the rest.

Heywood Floyd kept out of the Captain's way, not wishing to press his luck; in any event, Smith had a thousand details to attend to. But the calculation of the new orbit was not among them; that had been checked and rechecked on Earth.

There was no doubt, now, that the concept was brilliant, and the savings even greater than Jolson had claimed. By refuelling on Halley, Universe had eliminated the two major orbit changes involved in the rendezvous with Earth; she could now go straight to her goal, under maximum acceleration, saving many weeks. Despite the possible risks, everyone now applauded the scheme.

Well, almost everyone.

On Earth, the swiftly organized 'Hands off Halley!' society was indignant. Its members (a mere 236, but they knew how to drum up publicity) did not consider the rifling of a celestial body justified, even to save lives. They refused to be placated even when it was pointed out that Universe was merely borrowing material that the comet was about to lose anyway. It was, they argued, the principle of the thing. Their angry communiqués gave much needed light relief aboard Universe.

Cautious as ever, Captain Smith ran the first low-powered tests with one of the attitude-control thrusters; if this became unserviceable, the ship could manage without it. There were no anomalies; the engine behaved exactly as if it was running on the best distilled water from the lunar mines.

Then he tested the central main engine, Number One; if that was damaged, there would be no loss of manoeuvrability - only of total thrust. The ship would still be fully controllable, but, with the four remaining outboards alone, peak acceleration would be down by twenty per cent.

Again, there were no problems; even the sceptics started being polite to Heywood Floyd, and Second Officer Jolson was no longer a social outcast.

The lift-off was scheduled late in the afternoon, just before Old Faithful was due to subside. (Would it still be there to greet the next visitors in

seventy-six years' time? Floyd wondered. Perhaps; there were hints of its existence even back on the 1910 photographs.)

There was no countdown, in the dramatic oldtime Cape Canaveral style. When he was quite satisfied that everything was shipshape, Captain Smith applied a mere five tons of thrust on Number One, and Universe drifted slowly upwards and away from the comet.

The acceleration was modest, but the pyrotechnics were awe-inspiring - and, to most of the watchers, wholly unexpected. Until now, the jets from the main engines had been virtually invisible, being formed entirely of highly ionized oxygen and hydrogen. Even when - hundreds of kilometres away - the gases had cooled off enough to combine chemically, there was still nothing to be seen, because the reaction gave no light in the visible spectrum.

But now, Universe was climbing away from Halley on a column of incandescence too brilliant for the eye to look upon; it seemed almost a solid pillar of flame. Where it hit the ground, rock exploded upwards and outwards; as it departed for ever, Universe was carving its signature, like cosmic graffiti, across the nucleus of Halley's Comet.

Most of the passengers, accustomed to climbing spacewards with no visible means of support, reacted with considerable shock. Floyd waited for the inevitable explanation; one of his minor pleasures was catching Willis in some scientific error, but this very seldom happened. And even when it did, Willis always had some very plausible excuse.

'Carbon,' he said. 'Incandescent carbon - exactly as in a candle flame - but slightly hotter.'

'Slightly,' murmured Floyd.

'We're no longer burning - if you'll excuse the word -, (Floyd shrugged his shoulders) 'pure water. Although it's been carefully filtered, there's a

lot of colloidal carbon in it. As well as compounds that could only be removed by distillation.'

'It's very impressive, but I'm a little worried,' said Greenburg. 'All that radiation - won't it affect the engines - and heat the ship badly?'

It was a very good question, and it had caused some anxiety. Floyd waited for Willis to handle it; but that shrewd operator bounced the ball right back to him.

'I'd prefer Dr Floyd to deal with that - after all, it was his idea.'

'Jolson's, please. Good point, though. But it's no real problem; when we're under full thrust, all those fireworks will be a thousand kilometres behind us. We won't have to worry about them.'

The ship was now hovering some two kilometres above the nucleus; had it not been for the glare of the exhaust, the whole sunlit face of the tiny world would have been spread out beneath. At this altitude - or distance - the column of Old Faithful had broadened slightly. It looked, Floyd suddenly recalled, like one of the giant fountains ornamenting Lake Geneva. He had not seen them for fifty years, and wondered if they still played there.

Captain Smith was testing the controls, slowly rotating the ship, then pitching and yawing it along the Y and Z axes. Everything seemed to be functioning perfectly.

'Mission time zero is ten minutes from now,' he announced. '0.1 gee for fifty hours; then 0.2 until turnaround - one hundred and fifty hours from now.' He paused to let that sink in; no other ship had ever attempted to maintain so high a continuous acceleration, for so long. If Universe was not able to brake properly, she would also enter the history books as the first manned interstellar voyager.

The ship was now turning towards the horizontal - if that word could be used in this almost gravityless environment - and was pointing directly to the white column of mist and ice crystals still steadily spurting from the comet. Universe started to move towards it -

'What's he doing?' said Mihailovich anxiously.

Obviously anticipating such questions, the Captain spoke again. He seemed to have completely recovered his good humour, and there was a hint of amusement in his voice.

'Just one little chore before we leave, Don't worry - I know exactly what I'm doing. And Number Two agrees with me - don't you?'

'Yessir - though I thought you were joking at first.'

'What is going on up on the bridge?' asked Willis, for once at a loss.

Now the ship was starting a slow roll, while still moving at no more than a good walking speed towards the geyser. From this distance - now less than a hundred metres - it reminded Floyd still more closely of those far-off Geneva fountains.

Surely he's not taking us into it - But he was. Universe vibrated gently as it nuzzled its way into the rising column of foam. It was still rolling very slowly, as if it was drilling its way into the giant geyser. The video monitors and observation windows showed only a milky blankness.

The whole operation could not have lasted more than ten seconds; then they were out on the other side. There was a brief burst of spontaneous clapping from the officers on the bridge; but the passengers - even including Floyd - still felt somewhat put-upon.

'Now we're ready to go,' said the Captain, in tones of great satisfaction. 'We have a nice, clean ship again.'

During the next half-hour, more than ten thousand amateur observers on Earth and Moon reported that the comet had doubled its brightness. The Comet Watch Network broke down completely under the overload, and the professional astronomers were furious.

But the public loved it, and a few days later Universe put on an even better show, a few hours before dawn.

The ship, gaining speed by more than ten thousand kilometres an hour, every hour, was now far inside the orbit of Venus. It would get even closer to the sun before it made its perihelion passage - far more swiftly than any natural celestial body - and headed out towards Lucifer.

As it passed between Earth and Sun, the thousand kilometre tail of incandescent carbon was easily visible as a fourth magnitude star, showing appreciable movement against the constellations of the morning sky in the course of a single hour. At the very beginning of its rescue mission, Universe would be seen by more human beings, at the same moment, than any artefact in the history of the world.

35

Adrift

The unexpected news that their sister ship Universe was on the way - and might arrive far sooner than anyone had dared to dream - had an effect upon the morale of Galaxy's crew that could only be called euphoric. The mere fact that they were drifting helplessly on a strange ocean, surrounded by unknown monsters, suddenly seemed of minor importance.

As did the monsters themselves, though they made interesting appearances from time to time. The giant 'sharks' were sighted occasionally, but never came near the ship, even when garbage was dumped overboard. This was quite surprising; it strongly suggested that the great beasts - unlike their terrestrial counterparts - had a good system of communication. Perhaps they were more closely allied to dolphins than to sharks.

There were many schools of smaller fish, which no-one would have given a second glance in a market on Earth. After several attempts, one of the officers - a keen angler - managed to catch one with an unbaited hook. He never brought it in through the airlock - the Captain would not have permitted it, anyway - but measured and photographed it carefully before returning it to the sea.

The proud sportsman had to pay a price for his trophy, however. The partial-pressure spacesuit he had worn during the exercise had the characteristic 'rotten eggs' stink of hydrogen sulphide when he brought it back into the ship, and he became the butt of innumerable jokes. It was yet another reminder of an alien, and implacably hostile, biochemistry.

Despite the pleas of the scientists, no further angling was allowed. They could watch and record, but not collect. And anyway, it was pointed out, they were planetary geologists, not naturalists. No-one had thought of bringing formalin - which probably would not work here in any event.

Once, the ship drifted for several hours through floating mats or sheets of some bright green material. It formed ovals, about ten metres across, and all of approximately the same size. Galaxy ploughed through them without resistance, and they swiftly reformed behind her. It was guessed that they were colonial organisms of some kind.

And one morning, the officer of the watch was startled when a periscope rose out of the water and he found himself staring into a mild,

blue eye which, he said when he had recovered, looked like a sick cow's. It regarded him sadly for a few moments, without much apparent interest, then slowly returned to the ocean,

Nothing seemed to move very fast here, and the reason was obvious. This was still a low-energy world - there was none of the free oxygen that allowed the animals of Earth to live by a series of continuous explosions, from the moment they started to breathe at birth. Only the 'shark' of that first encounter had shown any sign of violent activity - in its last, dying spasm.

Perhaps that was good news for men. Even if they were encumbered with spacesuits, there was probably nothing on Europa that could catch them -even if it wanted to.

Captain Laplace found wry amusement in handing over the operation of his ship to the purser; he wondered if this situation was unique, in the annals of space and sea.

Not that there was a great deal that Mr Lee could do. Galaxy was floating vertically, one-third out of the water, heeling slightly before a wind that was driving it at a steady five knots. There were only a few leaks below the waterline, easily handled. Equally important, the hull was still airtight.

Although most of the navigation equipment was useless, they knew exactly where they were. Ganymede gave them an accurate fix on their emergency beacon every hour, and if Galaxy kept to her present course she would make landfall on a large island within the next three days. If she missed that, she would head on out to the open sea, and eventually reach the tepidly boiling zone immediately underneath Lucifer. Though not necessarily catastrophic, that was a most unattractive prospect; Acting Captain Lee spent much of his time thinking of ways to avoid it.

Sails - even if he had suitable material and rigging - would make very little difference to their course. He had lowered improvised sea-anchors down to five hundred metres, looking for currents that might be useful, and finding none. Nor had he found the bottom; it lay unknown kilometres further down.

Perhaps that was just as well; it protected them from the submarine quakes that continually racked this new ocean. Sometimes Galaxy would shake as if struck by a giant hammer, as a shockwave went racing by. In a few hours, a tsunami, dozens of metres high, would crash upon some European shore; but here in deep water the deadly waves were little more than ripples.

Several times, sudden vortexes were observed at a distance; they looked quite dangerous - maelstroms that might even suck Galaxy down to unknown depths - but luckily they were too far off to do more than make the ship spin around a few times in the water.

And just once, a huge bubble of gas rose and burst only a hundred metres away. It was most impressive, and everyone seconded the doctor's heartfelt comment: 'Thank God we can't smell it.'

It is surprising how quickly the most bizarre situation can become routine. Within a few days, life aboard Galaxy had settled down to a steady routine, and Captain Laplace's main problem was keeping the crew occupied. There was nothing worse for morale than idleness, and he wondered how the skippers of the old windjammers had kept their men busy on those interminable voyages. They couldn't have spent all their time scrambling up the rigging or cleaning the decks.

He had the opposite problem with the scientists. They were always proposing tests and experiments, which had to be carefully considered

before they could be approved. And if he allowed it, they would have monopolized the ship's now very limited communications channels.

The main antenna complex was now being battered around at the waterline, and Galaxy could no longer talk directly to Earth. Everything had to be relayed through Ganymede, on a bandwidth of a few miserable megahertz. A single live video channel pre-empted everything else, and he had to resist the clamour of the terrestrial networks. Not that they would have a great deal to show their audiences, except open sea, cramped ship interiors, and a crew which, though in good spirits, was becoming steadily more hirsute.

An unusual amount of traffic seemed directed to Second Officer Floyd whose encrypted responses were so brief that they could not have contained much information. Laplace finally decided to have a talk to the young man.

'Mr Floyd,' he said, in the privacy of his cabin. 'I'd appreciate it if you would enlighten me about your part-time occupation.'

Floyd looked embarrassed, and clutched at the table as the ship rocked slightly in a sudden gust.

'I wish I could, sir, but I'm not permitted.'

'By whom, may I ask?'

'Frankly, I'm not sure.'

That was perfectly true. He suspected it was ASTROPOL, but the two quietly impressive gentlemen who had briefed him on Ganymede had unaccountably failed to provide this information.

'As captain of this ship - especially in the present circumstances - I would like to know what's going on here. If we get out of this, I'm going to

spend the next few years of my life at Courts of Enquiry. And you'll probably be doing the same.'

Floyd managed a wry grin.

'Hardly worth being rescued, is it, Sir? All I know is that some high-level agency expected trouble on this mission, but didn't know what form it would take. I was just told to keep my eyes open. I'm afraid I didn't do much good, but I imagine I was the only qualified person they could get hold of in time.'

'I don't think you can blame yourself. Who would have imagined that Rosie -'

The Captain paused, struck by a sudden thought.

'Do you suspect anyone else?' He felt like adding 'Me, for instance?', but the situation was already sufficiently paranoiac.

Floyd looked thoughtful, then apparently came to a decision.

'Perhaps I should have spoken to you before, Sir, but I know how busy you've been. I'm sure Dr van der Berg is involved somehow. He's a Mede, of course; they're odd people, and I don't really understand them.' Or like them, he might have added. Too clannish - not really friendly to offworlders. Still, one could hardly blame them; all pioneers trying to tame a new wilderness were probably much the same.

'Van der Berg - hmm. What about the other scientists?'

'They've been checked, of course. All perfectly legitimate, and nothing unusual about any of them.'

That was not altogether true. Dr Simpson had more wives than was strictly legal, at least at one time, and Dr Higgins had a large collection of

most curious books. Second Officer Floyd was not quite sure why he had been told all this; perhaps his mentors merely wanted to impress him with their omniscience. He decided that working for ASTROPOL (or whoever it was) had some entertaining fringe benefits.

'Very well,' said the Captain, dismissing the amateur agent. 'But please keep me informed if you discover anything - anything at all- that might affect the safety of the ship.'

In the present circumstances, it was hard to imagine what that might be. Any further hazards seemed slightly superfluous.

36

The Alien Shore

Even twenty-four hours before they sighted the island, it was still not certain whether Galaxy would miss it and be blown on out into the emptiness of the central ocean. Her position, as observed by the Ganymede radar, was plotted on a large chart which everyone aboard examined anxiously several times a day.

Even if the ship did reach land, her problems might be just beginning. She might be pounded to pieces on a rocky coast, rather than gently deposited on some conveniently shelving beach.

Acting Captain Lee was keenly aware of all these possibilities. He had once been shipwrecked himself, in a cabin cruiser whose engines had failed at a critical moment, off the island of Bali. There had been little danger, though a good deal of drama, and he had no wish to repeat the experience - especially as there was no coastguard here to come to the rescue.

There was a truly cosmic irony in their plight. Here they were, aboard one of the most advanced transportation devices ever made by man - capable of crossing the Solar System! - yet now they could not deflect it more than a few metres from its course. Nevertheless, they were not completely helpless; Lee still had a few cards to play.

On this sharply curving world, the island was only five kilometres away when they first sighted it. To Lee's great relief, there were none of the cliffs he had feared; nor, on the other hand, was there any sign of the beach he had hoped for. The geologists had warned him that he was a few million years too early to find sand here; the mills of Europa, grinding slowly, had not yet had time to do their work.

As soon as it was certain they would hit the land, Lee gave orders to pump out Galaxy's main tanks, which he had deliberately flooded soon after touchdown. Then followed a very uncomfortable few hours, during which at least a quarter of the crew took no further interest in the proceedings.

Galaxy rose higher and higher in the water, oscillating more and more wildly - then tumbled with a mighty splash, to lie along the surface, like the corpse of a whale in the bad old days when the catcher-boats pumped them full of air to stop them sinking. When he saw how the ship was lying, Lee adjusted her buoyancy again, until she was slightly stern-down, and the forward bridge was just clear of the water.

As he expected, Galaxy then swung broadside-on to the wind. Another quarter of the crew became incapacitated then, but Lee had enough helpers to get out the sea-anchor he had prepared for this final act. It was merely an improvised raft, made of empty boxes lashed together, but its drag caused the ship to point towards the approaching land.

Now they could see that they were heading - with agonizing slowness - towards a narrow stretch of beach, covered with small boulders. If they could not have sand, this was the best alternative...

The bridge was already over the beach when Galaxy grounded, and Lee played his last card. He had made only a single test-run, not daring to do more in case the abused machinery failed.

For the last time, Galaxy extended her landing gear. There was a grinding and shuddering as the pads on the underside dug their way into the alien beach. Now she was securely anchored against the winds and waves of this tideless ocean.

There was no doubt that Galaxy had found her final resting place - and, all too possibly, that of her crew.

V

THROUGH
THE
ASTEROIDS

And now Universe was moving so swiftly that its orbit no longer even remotely resembled that of any natural object in the Solar System. Mercury, closest to the Sun, barely exceeds fifty kilometres a second at perihelion; Universe had reached twice that speed in the first day - and at only half the acceleration it would achieve when it was lighter by several thousand tons of water.

For a few hours, as they passed inside its orbit, Venus was the brightest of all heavenly bodies, next to the Sun and Lucifer. Its tiny disc was just visible to the naked eye, but even the ship's most powerful telescopes showed no markings whatever. Venus guarded her secrets as jealously as Europa.

By going still closer to the Sun - well inside the orbit of Mercury - Universe was not merely taking a short cut, but was also getting a free boost from the Sun's gravitational field. Because nature always balances her books, the Sun lost some velocity in the transaction; but the effect would not be measurable for a few thousand years.

Captain Smith used the ship's perihelion passage to restore some of the prestige his foot-dragging had cost him.

'Now you know,' he said, 'exactly why I flew the ship through Old Faithful. If we hadn't washed all that dirt off the hull, by this time we'd be badly overheating. In fact, I doubt if the thermal controls would have handled the load - it's already ten times Earth level.' Looking - through filters that were almost black - at the hideously swollen Sun, his passengers could easily believe him. They were all more than happy when it had shrunk back to normal size - and continued to dwindle astern as

Universe sliced across the orbit of Mars, outward bound on the final leg of its mission.

The 'Famous Five' had all adjusted, in their various ways, to the unexpected change in their lives. Mihailovich was composing copiously and noisily, and was seldom seen except when he emerged at meals, to tell outrageous stories and tease all available victims, especially Willis. Greenburg had elected himself, no-one dissenting, an honorary crew member, and spent much of his time on the bridge.

Maggie M viewed the situation with rueful amusement.

'Writers,' she remarked, 'are always saying what a lot of work they could do if they were only in some place with no interruptions - no engagements; lighthouses and prisons are their favourite examples. So I can't complain - except that my requests for research material keep getting delayed by high priority messages.'

Even Victor Willis had now come to much the same conclusion; he too was busily at work on sundry long-range projects. And he had an additional reason to keep to his cabin. It would still be several weeks before he looked as if he had forgotten to shave, and months before he returned to his full glory.

Yva Merlin spent hours every day in the entertainment centre, catching up - as she readily explained - with her favourite classics. It was fortunate that Universe's library and projection facilities had been installed in time for the voyage; though the collection was still relatively small, there was sufficient for several lifetimes of viewing.

All the famous works of visual art were there, right back to the flickering dawn of the cinema. Yva knew most of them, and was happy to share her knowledge.

Floyd, of course, enjoyed listening to her, because then she became alive - an ordinary human being, not an icon. He found it both sad and fascinating that only through an artificial universe of video images could she establish contact with the real world.

One of the strangest experiences of Heywood Floyd's fairly eventful life was sitting in semi-darkness just behind Yva, somewhere outside the orbit of Mars, while they watched the original *Gone with the Wind* together. There were moments when he could see her famous profile silhouetted against that of Vivien Leigh, and could compare the two - though it was impossible to say that one actress was better than the other; both were *sui generis*.

When the lights went up, he was astonished to see that Yva was crying. He took her hand and said tenderly: 'I cried too, when Bonny died.'

Yva managed a faint smile.

'I was really crying for Vivien,' she said. 'While we were shooting *Two*, I read a lot about her - she had such a tragic life. And talking about her, right out here between the planets, reminds me of something that Larry said when he brought the poor thing back from Ceylon after her nervous breakdown. He told his friends: "I've married a woman from outer space."

Yva paused for a moment, and another tear trickled (rather theatrically, Floyd could not help thinking) down her cheek.

'And here's something even stranger. She made her last movie exactly a hundred years ago - and do you know what it was?'

'Go on - surprise me again.'

'I expect it will surprise Maggie - if she's really writing the book she keeps threatening us with. Vivien's very last film was - *Ship of Fools*.'

Now that they had so much unexpected time on their hands, Captain Smith had finally agreed to give Victor Willis the long-delayed interview which was part of his contract. Victor himself had kept putting it off, owing to what Mihailovich persisted in calling his 'amputation'. As it would be many months before he could regenerate his public image, he had finally decided to do the interview off-camera; the studio on Earth could fake him in later with library shots.

They had been sitting in the Captain's still only partly furnished cabin, enjoying one of the excellent wines which apparently made up much of Victor's baggage allowance. As Universe would cut its drive and start coasting within the next few hours, this would be the last opportunity for several days. Weightless wine, Victor maintained, was an abomination; he refused to put any of his precious vintage into plastic squeezebulbs.

'This is Victor Willis, aboard the spaceship Universe at 18.30 on Friday, 15 July 2061. Though we're not yet at the mid-point of our journey, we're already far beyond the orbit of Mars, and have almost reached our maximum velocity. Which is, Captain?'

'One thousand and fifty kilometres a second.'

'More than a thousand kilometres a second -almost four million kilometres an hour!'

Victor Willis' surprise sounded perfectly genuine; no-one would have guessed that he knew the orbital parameters almost as well as did the Captain. But one of his strengths was his ability to put himself in the place

of his viewers, and not only to anticipate their questions, but to arouse their interest.

'That's right,' the Captain answered with quiet pride. 'We are travelling twice as fast as any human beings since the beginning of time.'

That should have been one of my lines, thought Victor; he did not like his subject to get ahead of him. But, good professional that he was, he quickly adapted.

He pretended to consult his famous little memo pad, with its sharply directional screen whose display only he could see.

'Every twelve seconds, we're travelling the diameter of Earth. Yet it will still take us another ten days to reach Jupi - ah, Lucifer! That gives some idea of the scale of the Solar System.

'Now, Captain, this is a delicate subject, but I've had a lot of questions about it during the last week.'

Oh no, groaned Smith. Not the zero gravity toilets again!

'At this very moment, we are passing right through the heart of the asteroid belt -'

(I wish it was the toilets, thought Smith...)

'- and though no spaceship has ever been seriously damaged by a collision, aren't we taking quite a risk? After all, there are literally millions of bodies, down to the size of beachballs, orbiting in this section of space. And only a few thousand have been charted.'

'More than a few: over ten thousand.'

'But there are millions we don't know about.'

'That's true; but it wouldn't help us much if we did.'

'What do you mean?'

'There's nothing we can do about them.'

'Why not?'

Captain Smith paused for careful thought. Willis was right - this was indeed a delicate subject; Head Office would rap his knuckles smartly, if he said anything to discourage potential customers.

'First of all, space is so enormous that even here - as you said, right in the heart of the asteroid belt - the chance of collision is - infinitesimal. We've been hoping to show you an asteroid - the best we can do is Hanuman, a miserable three hundred metres across - but the nearest we get to it is a quarter of a million kilometres.'

'But Hanuman is gigantic, compared to all the unknown debris that's floating around out here. Aren't you worried about that?'

'About as worried as you are, at being struck by lightning on Earth.'

'As a matter of fact, I once had a narrow escape, on Pike's Peak in Colorado - the flash and the bang were simultaneous. But you admit that the danger does exist - and aren't we increasing the risk, by the enormous speed at which we're travelling?'

Willis, of course, knew the answer perfectly well; once again he was putting himself in the place of his legions of unknown listeners on the planet that was getting a thousand kilometres further away with every passing second.

'It's hard to explain without mathematics,' said the Captain (how many times he had used that phrase. Even when it wasn't true!), 'but there's no simple relationship between speed and risk. To hit anything at spacecraft velocities would be catastrophic; if you're standing next to an atomic bomb when it goes off, it makes no difference whether it's in the kiloton or megaton class.'

That was not exactly a reassuring statement, but it was the best he could do. Before Willis could press the point further, he continued hastily:

'And let me remind you that any - er - slight extra risk we may be running is in the best of causes. A single hour may save lives.'

'Yes, I'm sure we all appreciate that.' Willis paused; he thought of adding 'And, of course, I'm in the same boat', but decided against it. It might sound immodest - not that modesty had ever been his strong suit. And anyway, he could hardly make a virtue of a necessity; he had very little alternative now, unless he decided to walk home.

'All this,' he continued, 'brings me to another point. Do you know what happened just a century and a half ago, on the North Atlantic?'

'In 1911?'

'Well, actually 1912 -'

Captain Smith guessed what was coming, and stubbornly refused to cooperate by pretending ignorance.

'I suppose you mean the Titanic,' he said.

'Precisely,' answered Willis, gamely concealing his disappointment. 'I've had at least twenty reminders from people who think they're the only one who's spotted the parallel.'

'What parallel? The Titanic was running unacceptable risks, merely trying to break a record.'

He almost added 'And she didn't have enough lifeboats', but luckily checked himself in time, when he recalled that the ship's one and only shuttle could carry not more than five passengers. If Willis took him up on that, it would involve altogether too many explanations.

'Well, I grant that the analogy is far-fetched. But there's another striking parallel which everyone points out. Do you happen to know the name of the Titanic's first and last Captain?'

'I haven't the faintest - ' began Captain Smith. Then his jaw dropped.

'Precisely,' said Victor Willis, with a smile which it would be charitable to call smug.

Captain Smith would willingly have strangled all those amateur researchers. But he could hardly blame his parents for bequeathing him the commonest of English names.

39

The Captain's Table

It was a pity that viewers on (and off) Earth could not have enjoyed the less formal discussions aboard Universe. Shipboard life had now settled down to a steady routine, punctuated by a few regular landmarks - of which the most important, and certainly the most long-established, was the traditional 'Captain's Table'.

At 18.00 hours exactly, the six passengers, and five of the officers not on duty, would join Captain Smith for dinner. There was, of course, none of the formal dress that had been mandatory aboard the floating palaces of the North Atlantic, but there was usually some attempt at sartorial novelty. Yva could always be relied upon to produce some new brooch, ring, necklace, hair-ribbon, or perfume from an apparently inexhaustible supply.

If the drive was on, the meal would begin with soup; but if the ship was coasting and weightless, there would be a selection of hors-d'oeuvres. In either event, before the main course was served Captain Smith would report the latest news - or try to dispel the latest rumours, usually fuelled by newscasts from Earth or Ganymede.

Accusations and countercharges were flying in all directions, and the most fantastic theories had been proposed to account for Galaxy's hijacking. A finger had been pointed at every secret organization known to exist, and many that were purely imaginary. All the theories, however, had one thing in common. Not one of them could suggest a plausible motive.

The mystery had been compounded by the one fact which had emerged. Strenuous detective work by ASTROPOL had established the surprising fact that the late 'Rose McCullen' was really Ruth Mason, born in North London, recruited to the Metropolitan Police - and then, after a promising start, dismissed for racist activities. She had emigrated to Africa - and vanished. Obviously, she had become involved in that unlucky continent's political underground. SHAKA was frequently mentioned, and as frequently denied by the USSA.

What all this could possibly have to do with Europa was endlessly, and fruitlessly, debated around the table - especially when Maggie M confessed that at one time she had been planning a novel about Shaka, from the viewpoint of one of his thousand unfortunate wives. But the more she researched the project, the more repellent it became. 'By the time I

abandoned Shaka,' she wryly admitted, 'I knew exactly what a modern German feels about Hitler.'

Such personal revelations became more and more common as the voyage proceeded. When the main meal was over, one of the group would be given the floor for thirty minutes. Between them; they had a dozen lifetimes of experience, on as many heavenly bodies, so it would be hard to find a better source of after-dinner tales.

The least effective speaker was, somewhat surprisingly, Victor Willis. He was frank enough to admit it, and to give the reason.

'I'm so used,' he said, almost but not quite apologetically, 'to performing for an audience of millions that I find it hard to interact with a friendly little group like this.'

'Could you do better if it wasn't friendly?' asked Mihailovich, always anxious to be helpful. 'That could easily be arranged.'

Yva, on the other hand, turned out to be better than expected, even though her memories were confined entirely to the world of entertainment. She was particularly good on the famous - and infamous - directors she had worked with, especially David Griffin.

'Was it true,' asked Maggie M, doubtless thinking of Shaka, 'that he hated women?'

'Not at all,' Yva answered promptly. 'He just hated actors. He didn't believe they were human beings.'

Mihailovich's reminiscences also covered a somewhat limited territory - the great orchestras and ballet companies, famous conductors and composers, and their innumerable hangers-on. But he was so full of hilarious stories of backstage intrigues and liaisons, and accounts of sabotaged first nights and mortal feuds among prima donnas, that he kept

even his most unmusical listeners convulsed with laughter, and was willingly granted extra time.

Colonel Greenburg's matter-of-fact accounts of extraordinary events could hardly have provided a greater contrast. The first landing at Mercury's - relatively - temperate south pole had been so thoroughly reported that there was little new to be said about it; the question that interested everyone was:

'When will we return?' That was usually followed by: 'Would you like to go back?'

'If they ask me to, of course I'll go,' Greenburg answered. 'But I rather think that Mercury is going to be like the Moon. Remember - we landed there in 1969 - and didn't go back again for half a lifetime. Anyway, Mercury isn't as useful as the Moon - though perhaps one day it may be. There's no water there; of course, it was quite a surprise to find any on the Moon. Or I should say in the Moon.

'Though it wasn't as glamorous as landing on Mercury, I did a more important job setting up the Aristarchus Mule-train.'

'Mule-train?'

'Yep. Before the big equatorial launcher was built, and they started shooting the ice straight into orbit, we had to haul it from the pit-head to the Imbrium Spaceport. That meant levelling a road across the lava plains and bridging quite a few crevasses. The Ice Road, we called it - only three hundred kilometres, but it took several lives to build...

'The "mules" were eight-wheeled tractors with huge tyres and independent suspension: they towed up to a dozen trailers, with a hundred

tons of ice apiece. Used to travel by night - no need to shield the cargo then.

'I rode with them several times. The trip took about six hours - we weren't out to break speed records - then the ice would be offloaded into big, pressurized tanks, waiting for sunrise. As soon as it melted, it would be pumped into the ships.

'The Ice Road is still there, of course, but only the tourists use it now. If they're sensible, they'll drive by night, as we used to do. It was pure magic, with the full Earth almost directly overhead, so brilliant that we seldom used our own lights. And although we could talk to our friends whenever we wanted to, we often switched off the radio and left it to the automatics to tell them we were OK. We just wanted to be alone, in that great shining emptiness - while it was still there, because we knew it wouldn't last.

'Now they're building the Teravolt quarksmasher, running right around the equator, and domes are going up all over Imbrium and Serenitatis. But we knew the real lunar wilderness, exactly as Armstrong and Aldrin saw it - before you could buy "Wish you were here" cards in the post office at Tranquillity Base.'

40

Monsters from Earth

'... lucky you missed the Annual Ball: believe it or not, it was just as grisly as last year's. And once again our resident mastodon, dear Ms Wilkinson, managed to crush her partners' toes, even on the Half-gee Dance Floor.

'Now some business. Since you won't be back for months, instead of a couple of weeks, Admin is looking lustfully at your apartment - good neighbourhood, near downtown shopping area, splendid view of Earth on clear days, etc., etc. - and suggests a sublet until you return. Seems a good deal, and will save you a lot of money. We'll collect any personal effects you'd like stored.

'Now this Shaka business. We know you love pulling our legs, but frankly Jerry and I were horrified! I can see why Maggie M turned him down -yes, of course we've read her Olympic Lusts - very enjoyable, but too feminist for us.

'What a monster - I can understand why they've called a gang of African terrorists after him. Fancy executing his warriors if they got married! And killing all the poor cows in his wretched empire, just because they were female! Worst of all - those horrid spears he invented; shocking manners, jabbing them into people you've not been properly introduced to...

'And what a ghastly advertisement for us feys! Almost enough to make one want to switch. We've always claimed that we're gentle and kindhearted (as well as madly talented and artistic, of course) but now you've made us look into some of the so-called Great Warriors (as if there was anything great about killing people!) we're almost ashamed of the company we've been keeping.

'Yes, we did know about Hadrian and Alexander - but we certainly didn't know about Richard the Lion Heart and Saladin. Or Julius Caesar - though he was everything - ask Antony as well as Cleo. Or Frederick the Great, who does have some redeeming features; look how he treated old Bach.

'When I told Jerry that at least Napoleon is an exception - we don't have to be saddled with him - do you know what he said? "I bet Josephine was really a boy." Try that on Yva.

'You've ruined our morale, you rascal, tarring us with that blood-stained brush (sorry about the mixed metaphor). You should have left us in happy ignorance...

'Despite that, we send our love, and so does Sebastian. Say hello to any Europeans you meet. Judging by the reports from Galaxy, some of them would make very good partners for Ms Wilkinson.'

41

Memoirs of a Centenarian

Dr Heywood Floyd preferred not to talk about the first mission to Jupiter, and the second to Lucifer ten years later. It was all so long ago - and there was nothing he had not said a hundred times to Congressional Committees, Space Council boards and media persons like Victor Willis.

Nevertheless, he had a duty to his fellow passengers which could not be avoided. As the only living man to have witnessed the birth of a new sun - and a new solar system - they expected him to have some special understanding of the worlds they were now so swiftly approaching. It was a naïve assumption; he could tell them far less about the Galilean satellites than the scientists and engineers who had been working there for more than a generation. When he was asked 'What's it really like on Europa?' (or Ganymede, or Io, or Callisto...) he was liable to refer the enquirer, rather brusquely, to the voluminous reports available in the ship's library.

Yet there was one area where his experience was unique. Half a century later, he sometimes wondered if it had really happened, or whether he had been asleep aboard Discovery when David Bowman had appeared to him. Almost easier to believe that a spaceship could be haunted...

But he could not have been dreaming, when the floating dust motes assembled themselves into that ghostly image of a man who should have been dead for a dozen years. Without the warning it had given him (how clearly he remembered that its lips were motionless, and the voice had come from the console speaker) Leonov and all aboard would have been vaporized in the detonation of Jupiter.

'Why did he do it?' Floyd asked during one of the after-dinner sessions. 'I've puzzled over that for fifty years. Whatever he became, after he went out in Discovery's space pod to investigate the monolith, he must still have had some links with the human race; he was not completely alien. We know that he returned to Earth - briefly - because of that orbiting bomb incident. And there's strong evidence that he visited both his mother and his old girlfriend; that's not the action of - of an entity that had discarded all emotions.'

'What do you suppose he is now?' asked Willis. 'For that matter - where is he?'

'Perhaps that last question has no meaning - even for human beings. Do you know where your consciousness resides?'

'I've no use for metaphysics. Somewhere in the general area of my brain, anyway.'

'When I was a young man,' sighed Mihailovich, who had a talent for deflating the most serious discussions, 'mine was about a metre lower down.'

'Let's assume he's on Europa; we know there's a monolith there, and Bowman was certainly associated with it in some way - see how he relayed that warning.'

'Do you think he also relayed the second one, telling us to stay away?'

'Which we are now going to ignore -'

' in a good cause -' Captain Smith, who was usually content to let the discussion go where it wished, made one of his rare interjections.

'Dr Floyd,' he said thoughtfully, 'you're in a unique position, and we should take advantage of it. Bowman went out of his way to help you once. If he's still around, he may be willing to do so again. I worry a good deal about that ATTEMPT NO LANDINGS HERE order. If he could assure us that it was - temporarily suspended, let's say - I'd be much happier.'

There were several 'hear, hear's around the table before Floyd answered.

'Yes, I've been thinking along the same lines. I've already told Galaxy to watch out for any - let's say manifestations - in case he tries to make contact.'

'Of course,' said Yva, 'he may be dead by now - if ghosts can die.'

Not even Mihailovich had a suitable comment to this, but Yva obviously sensed that no-one thought much of her contribution.

Undeterred, she tried again.

'Woody, dear,' she said. 'Why don't you simply give him a call on the radio? That's what it's for, isn't it?'

The idea had occurred to Floyd, but it had somehow seemed too naïve to take seriously.

'I will,' he said. 'I don't suppose it will do any harm.'

This time, Floyd was quite sure he was dreaming...

He had never been able to sleep well in zero gravity, and Universe was now coasting, unpowered, at maximum velocity. In two days it would start almost a week of steady deceleration, throwing away its enormous excess speed until it was able to rendezvous with Europa.

However many times he adjusted the restraining straps, they always seemed either too tight or too loose. He would have difficulty in breathing - or else he would find himself drifting out of his bunk.

Once he had awoken in mid-air, and had flailed away for several minutes until, exhausted, he had managed to 'swim' the few metres to the nearest wall. Not until then had he remembered that he should merely have waited; the room ventilating system would have soon pulled him to the exhaust grille without any exertion on his part. As a seasoned space-traveller, he knew this perfectly well; his only excuse was simple panic.

But tonight, he had managed to get everything right; probably when weight returned, he would have difficulty in readjusting to that. He had lain awake for only a few minutes, recapitulating the latest discussion at dinner, and had then fallen asleep.

In his dreams, he had continued the conversation around the table. There had been a few trifling changes, which he accepted without surprise. Willis, for example, had grown his beard back - though on only one side of his face. This, Floyd presumed, was in aid of some research project, though he found it difficult to imagine its purpose.

In any event, he had his own worries. He was defending himself against the criticisms of Space Administrator Millson, who had somewhat surprisingly joined their little group. Floyd wondered how he had come aboard Universe (could he possibly have stowed away?). The fact that Millson had been dead for at least forty years seemed much less important.

'Heywood,' his old enemy was saying, 'the White House is most upset.'

'I can't imagine why.'

'That radio message you've just sent to Europa. Did it have State Department clearance?'

'I didn't think it was necessary. I merely asked permission to land.'

'Ah - but that's it. Who did you ask? Do we recognize the government concerned? I'm afraid it's all very irregular...'

Millson faded away, still tut-tutting. I'm very glad this is only a dream, thought Floyd. Now what?

Well, I might have expected it. Hello, old friend. You come in all sizes, don't you? Of course, even TMA 1 couldn't have squeezed into my cabin - and its Big Brother could easily have swallowed Universe in one gulp.

The black monolith was standing - or floating - only two metres from his bunk. With an uncomfortable shock of recognition, Floyd realized that it was not only the same shape, but also the same size, as an ordinary tombstone. Although the resemblance had often been pointed out to him, until now the incongruity of scale had lessened the psychological impact. Now, for the first time, he felt the likeness was disquieting - even sinister. I know this is only a dream - but at my age, I don't want any reminders...

Anyway - what are you doing here? Do you bring a message from Dave Bowman? Are you Dave Bowman?

Well, I didn't really expect an answer; you weren't very talkative in the past, were you? But things always happened when you were around. Back in Tycho, sixty years ago, you sent that signal to Jupiter, to tell your makers that we'd dug you up. And look what you did to Jupiter, when we got there a dozen years later!

What are you up to now?

VI

HAVEN

The first task confronting Captain Laplace and his crew, once they had grown accustomed to being on terra firma, was to re-orient themselves. Everything on Galaxy was the wrong way round.

Spaceships are designed for two modes of operation - either no gravity at all, or, when the engines are thrusting, an up-and-down direction along the axis. But now Galaxy was lying almost horizontally, and all the floors had become walls. It was exactly as if they were trying to live in a lighthouse that had toppled on to its side; every single piece of furniture had to be moved, and at least fifty per cent of the equipment was not functioning properly.

Yet in some ways this was a blessing in disguise, and Captain Laplace made the most of it. The crew was so busy rearranging Galaxy's interior - giving priority to the plumbing - that he had few worries about morale. As long as the hull remained airtight, and the muon generators continued to supply power, they were in no immediate danger; they merely had to survive for twenty days, and salvation would come from the skies in the shape of Universe. No-one ever mentioned the possibility that the unknown powers that ruled Europa might object to a second landing. They had - as far as anyone knew - ignored the first; surely they could not interfere with a mission of mercy...

Europa itself, however, was now less cooperative. While Galaxy had been adrift on the open sea, it had been virtually unaffected by the quakes which continually racked the little world. But now that the ship had become an all too permanent land structure, it was shaken every few hours

by seismic disturbances. Had it touched down in the normal vertical position, by now it would certainly have been overturned.

The quakes were unpleasant rather than dangerous, but they gave nightmares to anyone who had experienced Tokyo '33 or Los Angeles '45. It did not help much to know that they followed a completely predictable pattern, rising to a peak of violence and frequency every three and a half days when Io came swinging past on its inner orbit. Nor was it much consolation to know that Europa's own gravitational tides were inflicting at least equal damage on Io.

After six days of gruelling work, Captain Laplace was satisfied that Galaxy was as near shipshape as was possible in the circumstances. He declared a holiday - which most of the crew spent sleeping - and then drew up a schedule for their second week on the satellite.

The scientists, of course, wanted to explore the new world they had so unexpectedly entered. According to the radar maps that Ganymede had transmitted to them, the island was fifteen kilometres long and five wide; its maximum elevation was only a hundred metres - not high enough, someone had gloomily predicted, to avoid a really bad tsunami.

It was hard to imagine a more dismal and forbidding place; half a century of exposure to Europa's feeble winds and rains had done nothing to break up the pillow lava which covered half its surface, or to soften the outcropping of granite that protruded through the rivers of frozen rock. But it was their home now, and they had to find a name for it.

Gloomy, downbeat suggestions like Hades, Inferno, Hell, Purgatory... were firmly vetoed by the Captain; he wanted something cheerful. One surprising and quixotic tribute to a brave enemy was seriously considered before being rejected thirty-two to ten, with five abstentions: the island would not be called 'Roseland'..

In the end, 'Haven' won unanimously.

'History never repeats itself - but historical situations recur.'

As he made his daily report to Ganymede, Captain Laplace kept thinking of the phrase. It had been quoted by Margaret M'Bala - now approaching at almost a thousand kilometres every second - in a message of encouragement from Universe which he had been very happy to relay to his fellow castaways.

'Please tell Miss M'Bala that her little history lesson was extremely good for morale; she couldn't have thought of anything better to send us.'

'Despite the inconvenience of having our walls and floors switched around, we're living in luxury compared to those old polar explorers. Some of us had heard of Ernest Shackleton, but we had no idea of the Endurance saga. To have been trapped on ice floes for over a year - then to spend the Antarctic winter in a cave - then to cross a thousand kilometres of sea in an open boat and to climb a range of unmapped mountains to reach the nearest human settlement!

'And yet that was only the beginning. What we find incredible - and inspiring - is that Shackleton went back four times to rescue his men on that little island - and saved every one of them! You can guess what that story's done to our spirits - I hope you can fax this book to us in your next transmission - we're all anxious to read it.'

'And what would he have thought of that! Yes, we're infinitely better off than any of those old-time explorers. It's almost impossible to believe that,

until well into the last century, they were completely cut off from the rest of the human race, once they'd gone over the horizon. We should be ashamed at grumbling because light isn't fast enough and we can't talk to our friends in real time - or that it takes a couple of hours to get replies from Earth... They had no contact for months - almost years! Again, Miss M'Bala - our sincerest thanks.

'Of course, all Earth explorers did have one considerable advantage over us; at least they could breathe the air. Our science team has been clamouring to go outside, and we've modified four spacesuits for EVAs of up to six hours. At this atmospheric pressure they won't need full suits - a waist seal is good enough - and I'm allowing two men to go out at a time, as long as they stay within sight of the ship.

'Finally, here's today's weather report. Pressure two hundred and fifty bars, temperature steady at twenty-five degrees, wind gusting at up to thirty klicks from the west, usual hundred per cent overcast, quakes between one and three on open-ended Richter...

'You know, I never did like the sound of that "open-ended" - especially now that Io's coming into conjunction again.

45

Mission

When people asked to see him together, it usually meant trouble, or at least some difficult decision. Captain Laplace had noticed that Floyd and van der Berg were spending a lot of time in earnest discussions, often with Second Officer Chang, and it was easy to guess what they were talking about. Yet their proposal still took him by surprise.

'You want to go to Mount Zeus! How - in an open boat? Has that Shackleton book gone to your head?'

Floyd looked slightly embarrassed; the Captain was right on target. South had been an inspiration, in more ways than one.

'Even if we could build a boat, Sir, it would take much too long... especially now that Universe looks like reaching us within ten days.'

'And I'm not sure,' added van der Berg, 'that I'd care to sail on this "Sea of Galilee"; not all its inhabitants may have got the message that we're inedible.'

'So that leaves only one alternative, doesn't it? I'm sceptical, but I'm willing to be convinced. Go on...

'We've discussed it with Mr Chang, and he confirms that it can be done. Mount Zeus is only three hundred kilometres away; the shuttle can fly there in less than an hour.'

'And find a place to land? As you doubtless recall, Mr Chang wasn't very successful with Galaxy.'

'No problem, Sir, The William Tsung's only a hundredth of our mass; even that ice could probably have supported it. We've been over the video records, and found a dozen good landing sites.'

'Besides,' said van der Berg, 'the pilot won't have a pistol pointed at him. That could help.'

'I'm sure it will. But the big problem is at this end. How are you going to get the shuttle out of its garage? Can you rig a crane? Even in this gravity, it would be quite a load.'

'No need to, Sir. Mr Chang can fly it out.'

There was a prolonged silence while Captain Laplace contemplated, obviously without much enthusiasm, the idea of rocket motors firing inside his ship. The small shuttle William Tsung, more familiarly known as Bill Tee, was designed purely for orbital operations; normally, it would be pushed gently out of its 'garage', and the engines would not operate until it was well away from the mother ship.

'Obviously you've worked all this out,' said the Captain grudgingly, 'but what about the angle of take-off? Don't tell me you want to roll Galaxy over so that Bill Tee can pop straight up? The garage is half-way down one side; lucky it wasn't underneath when we grounded.'

'The take-off will have to be at sixty degrees to the horizontal; the lateral thrusters can handle it.'

'If Mr Chang says so, I'll certainly believe him. But what will the firing do to the ship?'

'Well, it will wreck the garage interior - but it will never be used again, anyway. And the bulkheads are designed for accidental explosions, so there's no danger of damage to the rest of the ship. We'll have fire-fighting crews standing by, just in case.'

It was a brilliant concept - no doubt of that. If it worked, the mission would not be a total failure. During the last week, Captain Laplace had given scarcely a moment's thought to the mystery of Mount Zeus, which had brought them to this predicament: only survival had mattered. But now there was hope, and leisure to think ahead. It would be worth taking some risks, to find why this little world was the focus of so much intrigue.

46

Shuttle

'Speaking from memory,' said Dr Anderson, 'Goddard's first rocket flew about fifty metres. I wonder if Mr Chang will beat that record?'

'He'd better - or we'll all be in trouble.'

Most of the science team had gathered in the observation lounge, and everyone was staring anxiously back along the hull of the ship. Although the entrance of the 'garage' was not visible from this angle, they would see the Bill Tee soon enough, when - and if - it emerged.

There was no countdown; Chang was taking his time, making every possible check - and would fire when he felt like it. The shuttle had been stripped down to its minimum mass, and was carrying just enough propellant for one hundred seconds of flight. If everything worked, that would be ample; if it didn't, more would not only be superfluous, but dangerous.

'Here we go,' said Chang casually.

It was almost like a conjuring trick; everything happened so quickly that the eye was deceived. No one saw Bill Tee pop out of the garage, because it was hidden in a cloud of steam. When the cloud had cleared, the shuttle was already landing, two hundred metres away.

A great cheer of relief echoed through the lounge.

'He did it!' cried ex-Acting Captain Lee. 'He's broken Goddard's record - easily!'

Standing on its four stubby legs in the bleak European landscape, Bill Tee looked like a larger and even less elegant version of an Apollo lunar module. That was not, however, the thought that occurred to Captain Laplace, as he looked out from the bridge. It seemed to him that his ship was rather like a stranded whale, that had managed a difficult birth in an alien element. He hoped that the new calf would survive.

Forty-eight very busy hours later, the William Tsung was loaded, checked out on a ten-kilometre circuit over the island - and ready to go. There was still plenty of time for the mission; by the most optimistic reckoning, Universe could not arrive for another three days, and the trip to Mount Zeus, even allowing for the deployment of Dr van der Berg's extensive array of instruments, would take only six hours.

As soon as Second Officer Chang had landed, Captain Laplace called him to his cabin. The Skipper looked, thought Chang, somewhat ill at ease.

'Good work, Walter - but of course that's only what we expect.'

'Thanks, Sir, So what's the problem?'

The Captain smiled. A well-integrated crew could keep no secrets.

'Head Office, as usual. I hate to disappoint you, but I've had orders that only Dr van der Berg and Second Officer Floyd are to make the trip.'

'I get the picture,' Chang answered, with a trace of bitterness. 'What have you told them?'

'Nothing, yet; that's why I wanted to talk to you. I'm quite prepared to say that you're the only pilot who can fly the mission.'

'They'll know that's nonsense; Floyd could do the job as well as I could. There's not the slightest risk - except for a malfunction, which could happen to anyone.'

'I'd still be willing to stick my neck out, if you insist. After all, no-one can stop me - and we'll all be heroes when we get back to Earth.'

Chang was obviously doing some intricate calculations. He seemed rather pleased with the result.

'Replacing a couple of hundred kilos of payload with propellant gives us an interesting new option; I'd intended to mention it earlier, but there was no way Bill Tee could manage with all that extra gear and a full crew...'

'Don't tell me. The Great Wall.'

'Of course; we could do a complete survey in one or two passes, and find what it really is.'

'I thought we had a very good idea, and I'm not sure if we should go near it. That might be pressing our luck.'

'Perhaps. But there's another reason; to some of us, it's an even better one...'

'Go on.'

'Tsien. It's only ten kilometres from the Wall. We'd like to drop a wreath there.'

So that was what his officers had been discussing so solemnly; not for the first time, Captain Laplace wished he knew a little more Mandarin.

'I understand,' he said quietly. 'I'll have to think it over - and talk to van der Berg and Floyd to see if they agree.'

'And Head Office?'

'No, dammit. This will be my decision.'

47

Shards

'You'd better hurry,' Ganymede Central had advised, 'The next conjunction will be a bad one - we'll be triggering quakes as well as Io. And we don't want to scare you - but unless our radar's gone crazy, your mountain's sunk another hundred metres since the last check.'

At that rate, thought van der Berg, Europa will be flat again in ten years. How much faster things happened here than on Earth; which was one reason why the place was so popular with geologists.

Now that he was strapped into the number two position immediately behind Floyd, and virtually surrounded by consoles of his own equipment, he felt a curious mixture of excitement and regret. In a few hours, the great intellectual adventure of his life would be over - one way or the other. Nothing that would ever happen again could possibly match it.

He did not have the slightest trace of fear; his confidence in both man and machine was complete. One unexpected emotion was a wry sense of gratitude to the late Rose McCullen; without her, he would never have had this opportunity, but might have gone, still uncertain, to his grave.

The heavily laden Bill Tee could barely manage one-tenth of a gravity at lift-off; it was not intended for this sort of work, but would manage much better on the homeward journey when it had deposited its cargo. It seemed to take ages to climb clear of Galaxy, and they had ample time to note the damage to the hull as well as signs of corrosion from the occasional mildly acid rains. While Floyd concentrated on the lift-off, van der Berg gave a quick report on the ship's condition from the viewpoint of a privileged observer. It seemed the right thing to do - even though, with any luck, Galaxy's space-worthiness would soon be of no further concern to anyone.

Now they could see the whole of Haven spread out beneath them, and van der Berg realized what a brilliant job Acting Captain Lee had done when he beached the ship. There were only a few places where it could have been safely grounded; although a good deal of luck had also been involved, Lee had used wind and sea-anchor to the best possible advantage.

The mists closed around them; Bill Tee was rising on a semi-ballistic trajectory to minimize drag, and there would be nothing to see except the clouds for twenty minutes. A pity, thought van der Berg; I'm sure there must be some interesting creatures swimming around down there, and no-one else may have a chance of seeing them.

'Coming up to engine cut-off,' said Floyd. 'Everything normal.'

'Very good, Bill Tee. No report of traffic at your altitude. You're still number one on the runway to land.'

'Who's that joker?' asked van der Berg.

'Ronnie Lim. Believe it or not, that "number one on the runway" goes back to Apollo.'

Van der Berg could understand why. There was nothing like the occasional touch of humour - providing it was not overdone - to relieve the strain when men were involved in some complex and possibly hazardous enterprise.

'Fifteen minutes before we start braking,' said Floyd. 'Let's see who else is on the air.'

He started the autoscan, and a succession of beeps and whistles, separated by short silences as the tuner rejected them one by one in its swift climb up the radio spectrum, echoed round the little cabin.

'Your local beacons and data transmissions,' said Floyd. 'I was hoping - ah, here we are!'

It was only a faint musical tone, warbling rapidly up and down like a demented soprano. Floyd glanced at the frequency meter.

'Doppler shift almost gone - she's slowing fast.'

'What is it -text?'

'Slowscan video, I think. They're relaying a lot of material back to Earth through the big dish on Ganymede, when it's in the right position. The networks are yelling for news.'

They listened to the hypnotic but meaningless sound for a few minutes; then Floyd switched it off. Incomprehensible though the transmission from Universe was to their unaided senses, it conveyed the only message that mattered. Help was on the way, and would soon be there.

Partly to fill the silence, but also because he was genuinely interested, van der Berg remarked casually: 'Have you talked to your grandfather lately?'

'Talked', of course, was a misnomer where interplanetary distances were concerned, but no-one had come up with an acceptable alternative. 'Voicegram', 'audiomail' and 'vocard' had all flourished briefly, then vanished into limbo. Even now, most of the human race probably did not believe that realtime conversation was impossible in the Solar System's wide, open spaces, and from time to time indignant protests were heard: 'Why can't you scientists do something about it?'

'Yes,' said Floyd. 'He's in fine shape, and I look forward to meeting him.'

There was a slight strain in his voice. I wonder, thought van der Berg, when they last met; but he realized that it would be tactless to ask. Instead, he spent the next ten minutes rehearsing the off-loading and setting-up procedures with Floyd, so there would be no unnecessary confusion when they touched down.

The COMMENCE BRAKING alarm went off just a fraction of a second after Floyd had already started the program sequencer. I'm in good hands, thought van der Berg: I can relax and concentrate on my job. Where's that camera - don't say it's floated away again.

The clouds were clearing. Even though the radar had shown exactly what was beneath them, in a display as good as normal vision could provide, it was still a shock to see the face of the mountain rearing up only a few kilometres ahead.

'Look!' cried Floyd suddenly. 'Over to the left -by that double peak - give you one guess!'

'I'm sure you're right - I don't think we did any damage - it just splattered - wonder where the other one hit-'

'Altitude one thousand. Which landing site? Alpha doesn't look so good from here.'

'You're right - try Gamma - closer to the mountain, anyway.'

'Five hundred. Gamma it is. I'll hover for twenty secs - if you don't like it, we'll switch to Beta. Four hundred... Three hundred... Two hundred. ('Good luck, Bill Tee,' said Galaxy briefly). Thanks, Ronnie... One hundred and fifty... One hundred... Fifty... How about it? Just a few small rocks, and - that's peculiar - what looks like broken glass all over the place - someone's had a wild party here... Fifty... Fifty... Still OK?'

'Perfect. Go down.'

'Forty... thirty... twenty... Sure you don't want to change your mind?... Ten... Kicking up a little dust, as Neil said once - or was it Buzz?... Five... Contact! Easy, wasn't it? Don't know why they bother to pay me.'

48

Lucy

'Hello, Gany Central - we've made a perfect landing - I mean Chris has - on a flat surface of some metamorphic rock - probably the same pseudogranite we've called Havenite. The base of the mountain is only two kilometres away, but already I can tell there's no real need to go any closer.

'We're putting on our top-suits now, and will start unloading in five minutes. Will leave the monitors running, of course, and will call on every quarter-hour. Van out.'

'What did you mean by that "no need to go any closer"?' asked Floyd.

Van der Berg grinned. In the last few minutes he seemed to have shed years, and almost to have become a carefree boy.

'Circumspice,' he said happily. 'Latin for "look around you". Let's get the big camera out first - wow!'

The Bill Tee gave a sudden lurch, and for a moment heaved up and down on its landing-gear shock absorbers with a motion that, if it had continued for more than a few seconds, would have been a recipe for instant sea sickness.

'Ganymede was right about those quakes,' said Floyd, when they had recovered. 'Is there any serious danger?'

'Probably not; it's still thirty hours to conjunction, and this looks a solid slab of rock. But we won't waste any time here - luckily we won't need to. Is my mask straight? It doesn't feel right.'

'Let me tighten the strap. That's better. Breathe in hard - good, now it fits fine. I'll go first.'

Van der Berg wished that his could be the first small step, but Floyd was the commander and it was his duty to check that the Bill Tee was in good shape - and ready for an immediate take-off.

He walked once around the little spacecraft, examining the landing gear, then gave the thumbs-up signal to van der Berg, who started down the ladder to join him. Although he had worn the same lightweight breathing equipment on his exploration of Haven, he felt a little awkward with it, and paused at the landing pad to make some adjustments. Then he glanced up - and saw what Floyd was doing.

'Don't touch it!' he cried. 'It's dangerous!'

Floyd jumped a good metre away from the shards of vitreous rock he was examining. To his untrained eye, they looked rather like an unsuccessful melt from a large glass furnace.

'It's not radioactive, is it?' he asked anxiously. 'No. But stay away until I've got there.'

To his surprise, Floyd realized that van der Berg was wearing heavy gloves. As a space officer, it had taken him a long time to grow accustomed to the fact that, here on Europa, it was safe to expose one's bare skin to the atmosphere. Nowhere else in the Solar System - even on Mars - was that possible.

Very cautiously, van der Berg reached down and picked up a long splinter of the glassy material. Even in this diffused light, it glittered strangely, and Floyd could see that it had a vicious edge.

'The sharpest knife in the known universe,' said van der Berg happily.

'We've been through all this to find a knife!'

Van der Berg started to laugh, then found it wasn't easy inside his mask.

'So you still don't know what this is about?'

'I'm beginning to feel I'm the only one who doesn't.'

Van der Berg took his companion by the shoulder, and turned him to face the looming mass of Mount Zeus. From this distance, it filled half the sky - not merely the greatest, but the only mountain on this whole world.

'Admire the view just for one minute. I have an important call to make.'

He punched a code sequence on his comset, waited for the READY light to flash, and said: 'Ganymede Central 109 - this is Van. Do you receive?'

After no more than the minimum timelag, an obviously electronic voice answered:

'Hello, Van. This is Ganymede Central 109. Ready to receive.'

Van der Berg paused, savouring the moment he would remember for the rest of his life.

'Contact Earth Ident Uncle 737. Relay following message. LUCY IS HERE. LUCY IS HERE. End message. Please repeat.'

Perhaps I should have stopped him saying that, whatever it means, thought Floyd, as Ganymede repeated the message. But it's too late now. It will reach Earth within the hour.

'Sorry about that, Chris,' grinned van der Berg. 'I wanted to establish priority - amongst other things.'

'Unless you start talking soon, I'll begin carving you up with one of these patent glass knives.'

'Glass, indeed! Well, the explanation can wait - it's absolutely fascinating, but quite complicated. So I'll give you the straight facts.'

'Mount Zeus is a single diamond, approximate mass one million million tons. Or, if you prefer it that way, about two times ten to the seventeenth carats. But I can't guarantee that it's all gem quality.'

VII

**THE GREAT
WALL**

As they unloaded the equipment from Bill Tee and set it up on their little granite landing-pad, Chris Floyd found it hard to tear his eyes away from the mountain looming above them. A single diamond - bigger than Everest! Why, the scattered fragments lying round the shuttle must be worth billions, rather than millions.

On the other hand, they might be worth no more than - well, scraps of broken glass. The value of diamonds had always been controlled by the dealers and producers, but if a literal gem-mountain came suddenly on the market, prices would obviously collapse completely. Now Floyd began to understand why so many interested parties had focused their attention upon Europa; the political and economic ramifications were endless.

Now that he had at last proved his theory, van der Berg had become again the dedicated and single-minded scientist, anxious to complete his experiment with no further distraction. With Floyd's help - it was not easy to get some of the bulkier pieces of equipment out of Bill Tee's cramped cabin - they first drilled a metre-long core with a portable electric drill, and carried it carefully back to the shuttle.

Floyd would have had a different set of priorities, but he recognized that it made sense to do the harder tasks first. Not until they had laid out a seismograph array and erected a panoramic TV camera on a low, heavy tripod did van der Berg condescend to collect some of the incomputable riches lying all around them.

'At the very least,' he said, as he carefully selected some of the less lethal fragments, 'they'll make good souvenirs.'

'Unless Rosie's friends murder us to get them.'

Van der Berg looked sharply at his companion; he wondered how much Chris really knew - and how much, like all of them, he was guessing.

'Not worth their while, now that the secret's out. In about an hour's time, the Stock Exchange computers will be going crazy.'

'You bastard!' said Floyd, with admiration rather than rancour. 'So that's what your message was about.'

'There's no law that says a scientist shouldn't make a little profit on the side - but I'm leaving the sordid details to my friends on Earth. Honestly, I'm much more interested in the job we're doing here. Let me have that wrench, please...'

Three times before they had finished establishing Zeus Station they were almost knocked off their feet by quakes. They could feel them first as a vibration underfoot, then everything would start shaking - then there would be a horrible, long-drawn-out groaning sound that seemed to come from every direction. It was even air-borne, which to Floyd seemed strangest of all. He could not quite get used to the fact that there was enough atmosphere around them to allow short-range conversations without radio.

Van der Berg kept assuring him that the quakes were still quite harmless, but Floyd had learned never to put too much trust in experts. True, the geologist had just been proved spectacularly right; as he looked at Bill Tee heaving on its shock-absorbers like a storm-tossed ship, he hoped that Van's luck would hold for at least a few more minutes.

'That seems to be it,' said the scientist at last, to Floyd's great relief. 'Ganymede's getting good data on all channels. The batteries will last for years, with the solar panel to keep recharging them.'

'If this gear is still standing a week from now, I'll be very surprised. I'll swear that mountain's moved since we landed - let's get off before it falls on top of us.'

'I'm more worried,' laughed van der Berg, 'that your jet-blast will undo all our work.'

'No risk of that - we're well clear, and now we've offloaded so much junk we'll need only half-power to lift. Unless you want to take aboard a few more billions. Or trillions.'

'Let's not be greedy. Anyway, I can't even guess what this will be worth when we get it to Earth. The museums will grab most of it, of course. After that - who knows?'

Floyd's fingers were flying over the control panel as he exchanged messages with Galaxy.

'First stage of mission completed. Bill Tee ready for take-off. Flight plan as agreed.'

They were not surprised when Captain Laplace answered.

'You're quite certain you want to go ahead? Remember, you have the final decision. I'll back you up, whatever it is.'

'Yessir, we're both happy. We understand how the crew feels. And the scientific payoff could be enormous - we're both very excited.'

'Just a minute - we're still waiting for your report on Mount Zeus!'

Floyd looked at van der Berg, who shrugged his shoulders and then took the microphone.

'If we told you now, Captain, you'd think we were crazy - or pulling your leg. Please wait a couple of hours until we're back - with the evidence.'

'Hm. Not much point giving you an order, is it? Anyway - good luck. And from the owner as well - he thinks going to Tsien is a splendid idea.'

'I knew Sir Lawrence would approve,' Floyd remarked to his companion. 'And anyway - with Galaxy already a total loss, Bill Tee's not much extra risk, is it?'

Van der Berg could see his point of view, even though he did not entirely subscribe to it. He had made his scientific reputation; but he still looked forward to enjoying it.

'Oh - by the way,' Floyd said. 'Who was Lucy - anybody in particular?'

'Not as far as I know. We came across her in a computer search, and decided the name would make a good code word - everyone would assume it was something to do with Lucifer, which is just enough of a half-truth to be beautifully misleading....'

'I'd never heard of them, but a hundred years ago there was a group of popular musicians with a very strange name - the Beatles - spelled B-E-A-T-L-E-S, don't ask me why. And they wrote a song with an equally strange title: "Lucy in the Sky with Diamonds". Weird, isn't it? Almost as if they knew...'

According to Ganymede radar, the wreck of the Tsien lay three hundred kilometres west of Mount Zeus, towards the twilight zone and the cold lands beyond. Permanently cold they were, but not dark; half the time they were brilliantly lit by the distant Sun. However, even by the end of the long European solar day, the temperature was still far below freezing point.

As liquid water could exist only on the hemisphere facing Lucifer, the intermediate region was a place of continual storms, where rain and hail, sleet and snow contended for supremacy.

During the half-century since Tsien's disastrous landing, the ship had moved almost a thousand kilometres. It must have drifted - like Galaxy - for several years on the newly created Sea of Galilee, before coming to rest on its bleakly inhospitable shore.

Floyd picked up the radar echo as soon as Bill Tee flattened out at the end of its second leap across Europa. The signal was surprisingly weak for so large an object; as soon as they broke through the clouds, they realized why.

The wreck of the spaceship Tsien, first man-carrying vessel to land on a satellite of Jupiter, stood in the centre of a small, circular lake - obviously artificial, and connected by a canal to the sea, less than three kilometres away. Only the skeleton was left, and not even all of that; the carcass had been picked clean.

But by what? van der Berg asked. There was no sign of life there; the place looked as if it had been deserted for years. Yet he had not the slightest doubt that something had stripped the wreck, with deliberate and indeed almost surgical precision.

'Obviously safe to land,' said Floyd, waiting for a few seconds to get van der Berg's almost absentminded nod of approval. The geologist was already videoing everything in sight.

Bill Tee settled down effortlessly by the side of the pool, and they looked across the cold, dark water at this monument to man's exploring impulses. There seemed no convenient way of getting to the wreck, but that did not really matter.

When they had suited up, they carried the wreath to the water's edge, held it solemnly for a moment in front of the camera, then tossed in this tribute from Galaxy's crew. It had been beautifully made; even though the only raw materials available were metal foil, paper and plastic, one could easily believe that the flowers and leaves were real. Pinned all over them were notes and inscriptions, many written in the ancient but now officially obsolete script rather than Roman characters.

As they were walking back to the Bill Tee, Floyd said thoughtfully: 'Did you notice - there was practically no metal left. Only glass, plastic, synthetics.'

'What about those ribs and supporting girders?'

'Composite - mostly carbon, boron. Someone round here is very hungry for metal - and knows it when it sees it. Interesting...'

Very, thought van der Berg. On a world where fire could not exist, metals and alloys would be almost impossible to make, and as precious as - well, diamonds.

When he had reported to base, and received a message of gratitude from Second Officer Chang and his colleagues, Floyd took the Bill Tee up to a thousand metres and continued westward.

'Last lap,' he said, 'no point in going higher - we'll be there in ten minutes. But I won't land; if the Great Wall is what we think it is, I'd prefer not to. We'll do a quick flyby and head for home. Get those cameras ready; this could be even more important than Mount Zeus.'

And, he added to himself, I may soon know what Grandfather Heywood felt, not so far from here, fifty years ago. We'll have a lot to talk about when we meet - less than a week from now, if all goes well.

What a terrible place, thought Chris Floyd - nothing but driving sleet, flurries of snow, occasional glimpses of landscapes streaked with ice - why, Haven was a tropical paradise by comparison! Yet he knew that the nightside, only a few hundred kilometres further on round the curve of Europa, was even worse.

To his surprise, the weather cleared suddenly and completely just before they reached their goal. The clouds lifted - and there ahead was an immense, black wall, almost a kilometre high, lying directly across Bill Tee's flight path. It was so huge that it was obviously creating its own microclimate; the prevailing winds were being deflected around it, leaving a local, calm area in its lee.

It was instantly recognizable as the Monolith, and sheltering at its foot were hundreds of hemispherical structures, gleaming a ghostly white in the rays of the low-hanging sun that had once been Jupiter. They looked, thought Floyd, exactly like old-style beehives made of snow; something in their appearance evoked other memories of Earth. Van der Berg was one jump ahead of him.

'Igloos,' he said. 'Same problem - same solution. No other building material around here, except rock - which would be much harder to work. And the low gravity must help - some of those domes are quite large. I wonder what lives in them...'

They were still too far away to see anything moving in the streets of this little city at the edge of the world. And as they came closer, they saw that there were no streets.

'It's Venice, made of ice,' said Floyd. 'All igloos and canals.'

'Amphibians,' answered van der Berg. 'We should have expected it. I wonder where they are?'

'We may have scared them. Bill Tee's much noisier outside than in.'

For a moment, van der Berg was too busy filming and reporting to Galaxy to reply. Then he said: 'We can't possibly leave without making some contact. You're right - this is far bigger than Mount Zeus.'

'And it could be more dangerous.'

'I don't see any sign of advanced technology - correction, that looks like an old twentieth-century radar dish over there! Can you get closer?'

'And get shot at? No thanks. Besides, we're using up our hover time. Only another ten minutes - if you want to get home again.'

'Can we at least land and look around? There's a patch of clear rock over there. Where the hell is everybody?'

'Scared, like me. Nine minutes. I'll do one trip across town - film everything you can - yes, Galaxy - we're OK - just rather busy at the moment - call you later -'

'I've just realized - that's not a radar dish, but something almost as interesting. It's pointing straight at Lucifer - it's a solar furnace! Makes a lot of sense in a place where the sun never moves - and you can't light a fire.'

'Eight minutes. Too bad everyone's hiding indoors.'

'Or back in the water. Can we look at that big building with the open space around it? I think it's the town hall.'

Van der Berg was pointing towards a structure much larger than all the others, and of quite different design; it was a collection of vertical cylinders, like oversized organ-pipes. Moreover, it was not the featureless white of the igloos, but showed a complex mottling over its entire surface.

'European art!' cried van der Berg. 'That's a mural of some kind! Closer, closer! We must get a record!'

Obediently, Floyd dropped lower - and lower - and lower. He seemed to have completely forgotten all his earlier reservations about hover time; and suddenly, with shocked incredulity, van der Berg realized that he was going to land.

The scientist tore his eyes from the rapidly approaching ground, and glanced at his pilot. Though he was obviously still in full control of Bill Tee, Floyd seemed to be hypnotized; he was staring at a fixed point straight ahead of the descending shuttle.

'What's the matter, Chris?' van der Berg cried. 'Do you know what you're doing?'

'Of course. Can't you see him?'

'See who?'

'That man, standing by the biggest cylinder. And he's not wearing any breathing gear!'

'Don't be an idiot, Chris: there's no one there.'

'He's looking up at us. He's waving - I think I recog - Oh my God!'

'There's no-one - no-one! Pull up!'

Floyd ignored him completely. He was absolutely calm and professional as he brought Bill Tee in to a perfect landing, and cut the motor at exactly the right instant before touchdown.

Very thoroughly, he checked the instrument readings, and set the safety switches. Only when he had completed the landing sequence did he again look out of the observation window, with a puzzled but happy expression on his face.

'Hello, Grandfather,' he said softly, to no-one at all that van der Berg could see.

51

Phantom

Even in his most horrible nightmares, Dr van der Berg had never imagined being stranded on a hostile world in a tiny space capsule, with only a madman for company. But at least Chris Floyd did not seem to be violent; perhaps he could be humoured into taking off again and flying them safely back to Galaxy...

He was still staring at nothing, and from time to time his lips moved in silent conversation. The alien 'town' remained completely deserted, and one could almost imagine that it had been abandoned for centuries. Presently, however, van der Berg noticed some tell-tale signs of recent occupancy. Although Bill Tee's rockets had blasted away the thin layer of snow immediately around them, the remainder of the little square was still lightly powdered. It was a page torn from a book, covered with signs and hieroglyphics, some of which he could read.

A heavy object had been dragged in that direction - or had made its way clumsily under its own power. Leading from the now closed entrance of one igloo was the unmistakable track of a wheeled vehicle. Too far away to make out details was a small object that could have been a discarded container; perhaps Europeans were sometimes as careless as humans...

The presence of life was unmistakable, overwhelming. Van der Berg felt he was being watched by a thousand eyes - or other senses - and there was no way of guessing whether the minds behind them were friendly, or hostile. They might even be indifferent, merely waiting for the intruders to go away, so that they could continue their interrupted and mysterious business.

Then Chris Floyd spoke once again into the empty air.

'Goodbye, Grandfather,' he said quietly, with just a trace of sadness. Turning towards van der Berg he added in a normal conversational tone: 'He says it's time to leave. I guess you must think I'm crazy.'

It was wisest, decided van der Berg, not to agree. In any event, he soon had something else to worry about.

Floyd was now staring anxiously at the read-outs that Bill Tee's computer was feeding to him. Presently he said, in an understandable tone of apology:

'Sorry about this, Van. That landing used up more fuel than I'd intended. We'll have to change the mission profile.'

That, van der Berg thought bleakly, was a rather roundabout way of saying: 'We can't get back to Galaxy.' With difficulty, he managed to suppress a 'Damn your grandfather!' and merely asked: 'So what do we do?'

Floyd was studying the chart, and punching in more numbers.

'We can't stay here -, (Why not? thought van der Berg. If we're going to die anyway, we might use our time learning as much as possible.) ' - so we should find a place where the shuttle from Universe can pick us up easily.'

Van der Berg breathed a huge mental sigh of relief. Stupid of him not to have thought of that; he felt like a man who had been reprieved just when he was being taken to the gallows. Universe should reach Europa in less than four days; Bill Tee's accommodation could hardly be called luxurious, but it was infinitely preferable to most of the alternatives he could imagine.

'Away from this filthy weather - a stable, flat surface - closer to Galaxy, though I'm not sure if that helps much - shouldn't be any problem. We've enough for five hundred kilometres - it's just that we can't risk the sea crossing.'

For a moment, van der Berg thought wistfully of Mount Zeus; there was so much that could be done there. But the seismic disturbances - steadily getting worse as Io came into line with Lucifer - ruled that out completely. He wondered if his instruments were still working, and would check them again as soon as they'd dealt with the immediate problem.

'I'll fly down the coast to the equator - best place to be anyway for a shuttle landing - the radar map showed some smooth areas just inland round sixty west.'

'I know. The Masada Plateau.' (And, van der Berg added to himself, perhaps a chance for a little more exploring. Never miss an unexpected opportunity...)

'The Plateau it is. Goodbye, Venice. Goodbye, Grandfather...'

* * *

When the muted roar of the braking rockets had died away, Chris Floyd safetied the firing circuits for the last time, released his seat belt, and stretched arms and legs as far as he could in Bill Tee's confined quarters.

'Not such a bad view - for Europa,' he said cheerfully. 'Now we've four days to find out if shuttle rations are as bad as they claim. So - which of us starts talking first?'

52

On the Couch

I wish I'd studied some psychology, thought van der Berg; then I could explore the parameters of his delusion. Yet now he seems completely sane - except on that one subject.

Though almost any seat was comfortable at one-sixth of a gravity, Floyd had tilted his to the fully reclining position and had clasped his hands behind his head. Van der Berg suddenly recalled that this was the classic position of a patient, in the days of the old and still not entirely discredited Freudian analysis.

He was glad to let the other talk first, partly out of sheer curiosity but chiefly because he hoped that the sooner Floyd got this nonsense out of his system, the sooner he would be cured - or, at least, harmless. But he did not feel too optimistic: there must have been some serious, deep-seated problem in the first place to trigger so powerful an illusion.

It was very disconcerting to find that Floyd agreed with him completely, and had already made his own diagnosis.

'My crew psych rating is A1 plus,' he said, 'which means that they'll even let me look at my own files - only about ten per cent can do this. So I'm as baffled as you are - but I saw Grandfather, and he spoke to me. I've never believed in ghosts - who does? - but this must mean that he's dead. I wish I could have got to know him better - I'd been looking forward to our meeting... Still, now I have something to remember...'

Presently van der Berg asked: 'Tell me exactly what he said.'

Chris smiled a little wanly and answered: 'I've never had one of those total recall memories, and I was so stunned by the whole thing that I can't give you many of the actual words.' He paused, and a look of concentration appeared on his face.

'That's strange; now I look back, I don't think we did use words.'

Even worse, thought van der Berg; telepathy as well as survival after death. But he merely said:

'Well, give me the general gist of the - er - conversation. I never heard you say anything remember.'

'Right. He said something like, "I wanted to see you again, and I'm very happy. I'm sure everything is going to work out well, and Universe will soon pick you up."

Typical bland spirit message, thought van der Berg. They never say anything useful or surprising - merely reflect the hopes and fears of the listener. Zero-information echoes from the subconscious.

'Go on.'

'Then I asked him where everyone was - why the place was deserted. He laughed and gave me an answer I still don't understand. Something

like: "I know you didn't intend any harm - when we saw you coming, we barely had time to give the warning. All the - " and here he used a word I couldn't pronounce even if I could remember it - "got into the water - they can move quite quickly when they have to! They won't come out until you've left, and the wind has blown the poison away." What could he have meant by that? Our exhaust is nice, clean steam - and that's what most of their atmosphere is, anyway.'

Well, thought van der Berg, I suppose there's no law that says a delusion - any more than a dream - has to make logical sense. Perhaps the concept of 'poison' symbolizes some deep-rooted fear that Chris, despite his excellent psych rating, is unable to face. Whatever it is, I doubt if it's any concern of mine. Poison, indeed! Bill Tee's propellant mass is pure, distilled water shipped up to orbit from Ganymede.

But wait a minute. How hot is it when it comes out of the exhaust? Haven't I read somewhere... ?

'Chris,' said van der Berg cautiously, 'after the water's gone through the reactor, does it all come out as steam?'

'What else could it do? Oh, if we run really hot, ten or fifteen per cent gets cracked to hydrogen and oxygen.'

Oxygen! Van der Berg felt a sudden chill, even though the shuttle was at comfortable room temperature. It was most unlikely that Floyd understood the implications of what he had just said; the knowledge was outside his normal sphere of expertise.

'Did you know, Chris, that to primitive organisms on Earth, and certainly to creatures living in an atmosphere like Europa's, oxygen is a deadly poison?'

'You're joking.'

'I'm not: it's even poisonous to us, at high pressure.'

'I did know that; we were taught it in our diving course.'

'Your - grandfather - was talking sense. It's as if we'd sprayed that city with mustard gas. Well, not quite as bad as that - it would disperse very quickly.'

'So now you believe me.'

'I never said I didn't.'

'You would have been crazy if you did!'

That broke the tension, and they had a good laugh together.

'You never told me what he was wearing.'

'An old-fashioned dressing gown, just as I remembered when I was a boy. Looked very comfortable.'

'Any other details?'

'Now you mention it, he looked much younger, and had more hair than when I saw him last. So I don't think he was - what can I say? - real. Something like a computer-generated image. Or a synthetic hologram.'

'The Monolith!'

'Yes - that's what I thought. You remember how Dave Bowman appeared to Grandfather on Discovery? Perhaps it's his turn now. But why? He didn't give me any warning - not even any particular message. Just wanted to say goodbye and wish me well...'

For a few embarrassing moments Floyd's face began to crumple; then he regained control, and smiled at van der Berg.

'I've done enough talking. Now it's your turn to explain just what a million-million-ton diamond is doing - on a world made mostly of ice and sulphur. It had better be good.'

'It is,' said Dr Rolf van der Berg.

53

Pressure Cooker

'When I was studying at Flagstaff,' began van der Berg, 'I came across an old astronomy book that said: "The Solar System consists of the Sun, Jupiter - and assorted debris." Puts Earth in its place, doesn't it? And hardly fair to Saturn, Uranus and Neptune - the other three gas giants come to almost half as much as Jupiter.

'But I'd better start with Europa. As you know, it was flat ice before Lucifer started warming it up - greatest elevation only a couple of hundred metres - and it wasn't much different after the ice had melted and a lot of the water had migrated and frozen out on Farside. From 2015 - when our detailed observations began - until '38, there was only one high point on the whole moon - and we know what that was.'

'We certainly do. But even though I've seen it with my own eyes, I still can't picture the Monolith as a wall! I always visualize it as standing upright - or floating freely in space.'

'I think we've learned that it can do anything it wants to - anything we can imagine - and a lot more.'

'Well, something happened to Europa in '37, between one observation and the next. Mount Zeus - all of ten kilometres high! - suddenly appeared.

'Volcanoes that big don't pop up in a couple of weeks; besides, Europa's nothing like as active as Io.'

'It's active enough for me,' Floyd grumbled. 'Did you feel that one?'

'Besides, if it had been a volcano, it would have spewed enormous amounts of gas into the atmosphere; there were some changes, but nothing like enough to account for that explanation. It was all a complete mystery, and because we were scared of getting too close - and were busy on our own projects - we didn't do much except spin fantastic theories. None of them, as it turned out, as fantastic as the truth.

'I first suspected it from some chance observations in '57, but didn't really take them seriously for a couple of years. Then the evidence became stronger; for anything less bizarre, it would have been completely convincing.

'But before I could believe that Mount Zeus was made of diamond, I had to find an explanation. To a good scientist - and I think I'm a good one - no fact is really respectable until there's a theory to account for it. The theory may turn out to be wrong - it usually is, in some details at least - but it must provide a working hypothesis.

'And as you pointed out, a million-million-ton diamond on a world of ice and sulphur takes a little explaining. Of course, now it's perfectly obvious and I feel a damn fool not to have seen the answer years ago. Might have saved a lot of trouble - and at least one life - if I had.'

He paused thoughtfully, then suddenly asked Floyd:

'Anyone mention Dr Paul Kreuger to you?'

'No. Why should they? I've heard of him, of course.

'I just wondered. A lot of strange things have been going on, and I doubt if we'll ever know all the answers.

'Anyway, it's no secret now, so it doesn't matter. Two years ago I sent a confidential message to Paul - oh, sorry, I should have mentioned - he's my uncle - with a summary of my findings. I asked if he could explain them - or refute them.

'Didn't take him long, with all the byte-bashing he's got at his fingertips. Unfortunately, he was careless, or someone was monitoring his network - I'm sure your friends, whoever they are, must have a good idea by now.

'In a couple of days, he dug up an eighty-year-old paper in the scientific journal Nature - yes, it was still printed on paper back then! - which explained everything. Well, almost everything.

'It was written by a man working in one of the big labs in the United States - of America, of course - the USSA didn't exist then. It was a place where they designed nuclear weapons, so they knew a few things about high temperatures and pressures.

'I don't know if Dr Ross - that was his name - had anything to do with bombs, but his background must have started him thinking about conditions deep down inside the giant planets. In his 1984 - sorry, 1981 - paper - it's less than a page long, by the way - he made some very interesting suggestions...

'He pointed out that there were gigantic quantities of carbon - in the form of methane, CH₄ - in the gas giants. Up to seventeen per cent of the total mass! He calculated that at the pressures and temperatures in the cores - millions of atmospheres - the carbon would separate out, sink

down towards the centres and - you've guessed it - crystallize. It was a lovely theory: I don't suppose he ever dreamed that there would be a hope of testing it.

'So that's part one of the story. In some ways, part two is even more interesting. What about some more of that coffee?'

'Here you are; and I think I've already guessed part two. Obviously something to do with the explosion of Jupiter.'

'Not explosion - implosion - Jupiter just collapsed on itself, then ignited. In some ways, it was like the detonation of a nuclear bomb, except that the new state was a stable one - in fact, a minisun.

'Now, very strange things happen during implosions; it's almost as if pieces can go through each other, and come out on the other side. Whatever the mechanism, a mountain-sized piece of the diamond core was shot into orbit.

'It must have made hundreds of revolutions - been perturbed by the gravitational fields of all the satellites - before it ended up on Europa. And conditions must have been exactly right - one body must have overtaken the other, so the impact velocity was only a couple of kilometres a second. If they'd met head-on - well, there might not be a Europa now, let alone Mount Zeus! And I sometimes have nightmares, thinking that it could very well have come down on us...

'The new atmosphere may also have buffered the impact; even so, the shock must have been appalling - I wonder what it did to our European friends? - it certainly triggered a whole series of tectonic disturbances, which are still continuing.'

'And,' said Floyd, 'political ones. I'm just beginning to appreciate some of them. No wonder the USSA was worried.'

'Amongst others.'

'But would anyone seriously imagine they could get at these diamonds?'

'We've not done so badly,' answered van der Berg, gesturing towards the back of the shuttle. 'In any case, the mere psychological effect on the industry would be enormous. That's why so many people were anxious to know whether it was true or not.'

'And now they know. What next?'

'That's not my problem, thank God. But I hope I've made a sizeable contribution to Ganymede's science budget.'

As well as my own, he added to himself.

54

Reunion

'Whatever made you think I was dead?' cried Heywood Floyd. 'I've not felt better for years!'

Paralysed with astonishment, Chris Floyd stared at the speaker grille. He felt a great lifting of his spirits - yet also a sense of indignation. Someone - something - had played a cruel practical joke on him; but for what conceivable reason?

Fifty million kilometres away - and coming closer by several hundred every second - Heywood Floyd also sounded slightly indignant. But he also sounded vigorous and cheerful, and his voice radiated the happiness he obviously felt at knowing that Chris was safe.

'And I've got some more good news for you; the shuttle will pick you up first. It will drop some urgent medical supplies at Galaxy, then hop over to you, and bring you up to rendezvous with us on the next orbit. Universe will go down five orbits later; you'll be able to greet your friends when they come aboard.

'No more now - except to say how much I'm looking forward to making up for lost time. Waiting for your answer in - let's see - about three minutes...'

For a moment, there was complete silence aboard Bill Tee; van der Berg dared not look at his companion. Then Floyd keyed the microphone and said slowly: 'Grandad - what a wonderful surprise - I'm still in a state of shock. But I know I met you here on Europa - I know you said goodbye to me. I'm as certain of that, as I'm sure you were speaking to me just now...

'Well, we'll have plenty of time to talk about it later. But remember how Dave Bowman spoke to you, aboard Discovery? Perhaps it was something like that.

'Now we'll just sit and wait here until the shuttle comes for us. We're quite comfortable - there's an occasional quake, but nothing to worry about. Until we meet, all my love.'

He could not remember when he had last used that word to his grandfather.

After the first day, the shuttle cabin began to smell. After the second, they didn't notice - but agreed that the food was no longer quite so tasty. They also found it hard to sleep, and there were even accusations of snoring.

On day three, despite frequent bulletins from Universe, Galaxy and Earth itself, boredom was beginning to set in, and they had exhausted their supply of dirty stories.

But that was the last day. Before it was over, Lady Jasmine descended, seeking her lost child.

55

Magma

'Baas,' said the apartment's master comset, 'I accessed that special programme from Ganymede while you were sleeping. Do you wish to see it now?'

'Yes,' answered Dr Paul Kreuger. 'Speed ten times. No sound.'

There would, he knew, be a lot of introductory material he could jump, and view later if he wished. He wanted to get to the action as quickly as possible.

Credits flashed up, and there on the monitor was Victor Willis, somewhere on Ganymede, gesticulating wildly in total silence. Dr Paul Kreuger, like many working scientists, took a somewhat jaundiced view of Willis, though he admitted that he performed a useful function.

Willis abruptly vanished, to be replaced by a less agitated subject - Mount Zeus. But that was much more active than any well-behaved mountain should be; Dr Kreuger was astonished to see how much it had changed since the last transmission from Europa.

'Real time,' he ordered. 'Sound.'

'...almost a hundred metres a day, and the tilt has increased fifteen degrees. Tectonic activity now violent - extensive lava flows around the base - I have Dr van der Berg with me - Van, what do you think?'

My nephew looks in remarkably good shape, thought Dr Kreuger, considering what he's been through. Good stock, of course.

'The crust obviously never recovered from the original impact, and it's giving way under the accumulated stresses. Mount Zeus has been slowly sinking ever since we discovered it, but the rate has speeded up enormously in the last few weeks. You can see the movement from day to day.'

'How long before it disappears completely?'

'I can't really believe that will happen...'

There was a quick cut to another view of the mountain, with Victor Willis speaking off camera.

'That was what Dr van der Berg said two days ago. Any comment now, Van?'

'Er - it looks as if I was mistaken. It's going down - quite incredible - only half a kilometre left! I refuse to make any more predictions...'

'Very wise of you, Van - well, that was only yesterday. Now we'll give you a continuous time-lapse sequence, up to the moment we lost the camera...'

Dr Paul Kreuger leaned forward in his seat, watching the final act of the long drama in which he had played such a remote, yet vital role.

There was no need to speed up the replay: he was already seeing it at almost a hundred times normal. An hour was compressed into a minute - a man's lifetime into that of a butterfly.

Before his eyes, Mount Zeus was sinking. spurts of molten sulphur rocketed skywards around it at dazzling speed, forming parabolas of brilliant, electric blue. It was like a ship going down in a stormy sea, surrounded by St Elmo's fire. Not even Io's spectacular volcanoes could match this display of violence.

'The greatest treasure ever discovered - vanishing from sight,' said Willis in hushed and reverential tones: 'Unfortunately, we can't show the finale. You'll soon see why.'

The action slowed down into real time. Only a few hundred metres of the mountain were left, and the eruptions around it now moved at a more leisurely speed.

Suddenly, the whole picture tilted; the camera's image stabilizers, which had been holding their own valiantly against the continuous trembling of the ground, gave up the unequal battle. For a moment it seemed as if the mountain was rising again - but it was the camera tripod toppling over. The very last scene from Europa was a close-up of a glowing wave of molten sulphur, about to engulf the equipment.

'Gone for ever!' lamented Willis. 'Riches infinitely greater than all the wealth that Golconda or Kimberley ever produced! What a tragic, heartbreaking loss!'

'What a stupid idiot!' spluttered Dr Kreuger. 'Doesn't he realize...'

It was time for another letter to Nature. And this secret would be much too big to hide.

56

Perturbation Theory

From: Professor Paul Kreuger, FRS, etc.

To: The Editor, NATURE Data Bank (Public access)

Subject: MOUNT ZEUS AND JOVIAN DIAMONDS

As is now well understood, the European formation known as 'Mount Zeus' was originally part of Jupiter. The suggestion that the cores of the gas giants might consist of diamond was first made by Marvin Ross of the University of California's Lawrence Livermore National Laboratory in a classic paper 'The ice layer in Uranus and Neptune - diamonds in the sky?' (Nature, Vol 292, No. 5822, pp. 435-6, 30 July 1981). Surprisingly, Ross did not extend his calculations to Jupiter.

The sinking of Mount Zeus has produced a veritable chorus of lamentations, all of which are totally ridiculous - for the reasons given below.

Without going into details, which will be presented in a later communication, I estimate that the diamond core of Jupiter must have had an original mass of at least 10^{28} grams. This is ten billion times that of Mount Zeus.

Although much of this material would doubtless have been destroyed in the detonation of the planet and the formation of the - apparently artificial - sun Lucifer, it is inconceivable that Mount Zeus was the only fragment to survive. Although much would have fallen back on to Lucifer, a

substantial percentage must have gone into orbit - and must still be there. Elementary perturbation theory shows that it will return periodically to its point of origin. It is not, of course, possible to make an exact calculation, but I estimate that at least a million times the mass of Mount Zeus is still orbiting in the vicinity of Lucifer. The loss of one small fragment, in any case most inconveniently located on Europa, is therefore of virtually no importance. I propose the establishment, as soon as possible, of a dedicated space-radar system to search for this material.

Although extremely thin diamond film has been mass-produced since as long ago as 1982, it has never been possible to make diamond in bulk. Its availability in megaton quantities could totally transform many industries and create wholly new ones. In particular, as was pointed out by Isaacs et al almost a hundred years ago (see *Science*, 151, pp. 682-3, 1966) diamond is the only construction material which would make possible the so-called 'Space elevator', allowing transportation away from Earth at negligible cost. The diamond mountains now orbiting among the satellites of Jupiter may open up the entire Solar System; how trivial, by comparison, appear all the ancient uses of the quartic-crystallized form of carbon!

For completeness, I would like to mention another possible location for enormous quantities of diamond - a place, unfortunately, even more inaccessible than the core of a giant planet...

It has been suggested that the crusts of neutron stars may be largely composed of diamond. As the nearest known neutron star is fifteen light years away, and has a surface gravity seventy thousand million times that of Earth, this can hardly be regarded as a plausible source of supply.

But then - who could ever have imagined that one day we would be able to touch the core of Jupiter?

Interlude on Ganymede

'These poor, primitive colonists!' lamented Mihailovich. 'I'm horrified - there's not a single concert grand on the whole of Ganymede! Of course, the thimbleful of optronics in my synthesizer can reproduce any musical instrument. But a Steinway is still a Steinway - just as a Strad is still a Strad.'

His complaints, though not altogether serious, had already aroused some counter-reactions among the local intelligentsia. The popular Morning Mede programme had even commented maliciously: 'By honouring us with their presence, our distinguished guests have - if only temporarily - raised the cultural level of both worlds...'

The attack was aimed chiefly at Willis, Mihailovich and M'Bala, who had been a little too enthusiastic in bringing enlightenment to the backward natives. Maggie M had created quite a scandal with an uninhibited account of Zeus-Jupiter's torrid love affairs with Io, Europa, Ganymede and Callisto. Appearing to the nymph Europa in the guise of a white bull was bad enough, and his attempts to shield Io and Callisto from the understandable wrath of his consort Hera were frankly pathetic. But what upset many local residents was the news that the mythological Ganymede was of quite the wrong gender.

To do them justice, the intentions of the self-appointed cultural ambassadors were completely praiseworthy, though not entirely disinterested. Knowing that they would be stranded on Ganymede for months, they recognized the danger of boredom, after the novelty of the situation had worn off. And they also wished to make the best possible use of their talents, for the benefit of everyone around them. However, not everyone wished - or had time - to be benefited, out here on the high-technology frontier of the Solar System.

Yva Merlin, on the other hand, fitted in perfectly, and was thoroughly enjoying herself. Despite her fame on Earth, few of the Medes had ever heard of her. She could wander around, in the public corridors and pressure domes of Ganymede Central, without people turning their heads or exchanging excited whispers of recognition. True, she was recognized - but only as another of the visitors from Earth.

Greenburg, with his usual quietly efficient modesty, had fitted into the administrative and technological structure of the satellite and was already on half a dozen advisory boards. His services were so well appreciated that he had been warned he might not be allowed to leave.

Heywood Floyd observed the activities of his shipmates with relaxed amusement, but took little part in them. His chief concern now was building bridges to Chris, and helping his grandson plan his future. Now that Universe - with less than a hundred tons of propellant left in its tanks - was safely down on Ganymede, there was much to be done.

The gratitude that all aboard Galaxy felt towards their rescuers had made it easy to merge the two crews; when repairs, overhaul and refuelling were complete, they would fly back to Earth together. Morale had already been given a great boost by the news that Sir Lawrence was drawing up the contract for a greatly improved Galaxy II - though construction was not likely to begin until his lawyers had settled their dispute with Lloyd's. The underwriters were still trying to claim that the novel crime of space hijacking was not covered by their policy.

As for that crime itself, no-one had been convicted, or even charged. Clearly, it had been planned, over a period of several years, by an efficient and well-funded organization. The United States of Southern Africa loudly protested innocence, and said it welcomed an official enquiry. Der Bund also expressed indignation, and of course blamed SHAKA.

Dr Kreuger was not surprised to find angry but anonymous messages in his mail, accusing him of being a traitor. They were usually in Afrikaans, but sometimes contained subtle mistakes in grammar or phraseology which made him suspect that they were part of a disinformation campaign.

After some thought, he passed them onto ASTROPOL - which probably already has them, he told himself wryly. ASTROPOL thanked him, but, as he expected, made no comments.

At various times, Second Officers Floyd and Chang and other members of Galaxy's crew were treated to the best dinners on Ganymede by the two mysterious out-wonders whom Floyd had already met. When the recipients of these (frankly disappointing) meals compared notes afterwards, they decided that their polite interrogators were trying to build up a case against SHAKA, but were not getting very far.

Dr van der Berg, who had started the whole thing - and had done very well out of it, professionally and financially - was now wondering what to do with his new opportunities. He had received many attractive offers from Earth universities and scientific organizations - but, ironically, it was impossible to take advantage of them. He had now lived too long at Ganymede's one-sixth of a gravity, and had passed the medical point of no return.

The Moon remained a possibility; so did Pasteur, as Heywood Floyd explained to him.

'We're trying to set up a space university there,' he said, 'so that off-worlders who can't tolerate one gee can still interact in real time with people on Earth. We'll have lecture halls, conference rooms, labs - some of them will only be computer-stored, but they'll look so real you'd never know. And you'll be able to go videoshopping on Earth, to make use of your ill-gotten gains.'

To his surprise, Floyd had not only rediscovered a grandson - he had adopted a nephew; he was now linked to van der Berg as well as Chris by a unique mix of shared experiences. Above all, there was the mystery of the apparition in the deserted European city, beneath the looming presence of the Monolith.

Chris had no doubts whatsoever. 'I saw you, and heard you, as clearly as I do now,' he told his grandfather. 'But your lips never moved - and the strange thing is that I didn't feel that was strange - it seemed perfectly natural. The whole experience had a - relaxed feeling about it. A little sad - no, wistful would be a better word. Or maybe resigned.'

'We couldn't help thinking of your encounter with Bowman, aboard Discovery,' added van der Berg.

'I tried to radio him before we landed on Europa. It seemed a naïve thing to do, but I couldn't imagine any alternative. I felt sure he was there, in some form or other.'

'And you never had any kind of acknowledgement?'

Floyd hesitated. The memory was fading fast, but he suddenly recalled that night when the mini-monolith had appeared in his cabin.

Nothing had happened, yet from that moment onwards he had felt that Chris was safe, and that they would meet again.

'No,' he said slowly. 'I never had any reply.' After all, it could only have been a dream.

VIII

**THE
KINGDOM
OF
SULPHUR**

Before the age of planetary exploration opened in the late twentieth century, few scientists would have believed that life could have flourished on a world so far from the Sun. Yet for half a billion years, the hidden seas of Europa had been at least as prolific as those of Earth.

Before the ignition of Jupiter, a crust of ice had protected those oceans from the vacuum above. In most places the ice was kilometres thick, but there were lines of weakness where it had cracked open and torn apart. Then there had been a brief battle between two implacably hostile elements, which came into direct contact on no other world in the Solar System. The war between Sea and Space always ended in the same stalemate; the exposed water simultaneously boiled and froze, repairing the armour of ice.

The seas of Europa would have frozen completely solid long ago, without the influence of nearby Jupiter. Its gravity continually kneaded the core of this little world; the forces that convulsed Io were also working here, though with much less ferocity. The tug of war between planet and satellite caused continual submarine earthquakes, and avalanches which swept with amazing speed across the abyssal plains.

Scattered across those plains were countless oases, each extending for a few hundred metres around a cornucopia of mineral brines gushing from the interior. Depositing their chemicals in a tangled mass of pipes and chimneys, they sometimes created natural parodies of ruined castles or Gothic cathedrals, from which black, scalding liquids pulsed in a slow rhythm, as if driven by the beating of some mighty heart. And, like blood, they were the authentic sign of life itself.

The boiling fluids drove back the deadly cold leaking down from above, and formed islands of warmth on the seabed. Equally important, they brought from Europa's interior all the chemicals of life. Here, in an environment which would otherwise be totally hostile, were abundant energy and food. Such geothermal vents had been discovered in Earth's oceans, in the same decade that had given mankind its first glimpse of the Galilean satellites.

In the tropical zones close to the vents flourished myriads of delicate, spidery creatures that were the analogues of plants, though almost all were capable of movement. Crawling among these were bizarre slugs and worms, some feeding on the 'plants', others obtaining their food directly from the mineral-laden waters around them. At greater distances from the source of heat - the submarine fire around which all these creatures warmed themselves - were sturdier, more robust organisms, not unlike crabs or spiders.

Armies of biologists could have spent lifetimes studying a single small oasis. Unlike the Palaeozoic terrestrial seas, Europa's hidden ocean was not a stable environment, so evolution had progressed swiftly here, producing multitudes of fantastic forms. And they were all under indefinite stay of execution; sooner or later, each fountain of life would weaken and die, as the forces that powered it moved their focus elsewhere. The abyss was littered with the evidence of such tragedies - cemeteries holding skeletons and mineral-encrusted remains where entire chapters had been deleted from the book of life.

There were huge shells, looking like trumpets larger than a man. There were clams of many shapes - bivalves, and even trivalves. And there were spiral stone patterns, many metres across, which seemed an exact analogy of the beautiful ammonites that disappeared so mysteriously from Earth's oceans at the end of the Cretaceous period.

In many places, fires burned in the abyss, as rivers of incandescent lava flowed for scores of kilometres along sunken valleys. The pressure at this depth was so great that the water in contact with the red-hot magma could not flash into steam, and the two liquids co-existed in an uneasy truce.

Here, on another world and with alien actors, something like the story of Egypt had been played long before the coming of man. As the Nile had brought life to a narrow ribbon of desert, so these rivers of warmth had vivified the European deep. Along their banks, in bands seldom more than a kilometre wide, species after species had evolved and flourished and passed away. And some had left monuments behind, in the shape of rocks piled on top of each other, or curious patterns of trenches engraved in the seabed.

Along the narrow bands of fertility in the deserts of the deep, whole cultures and primitive civilizations had risen and fallen. And the rest of their world had never known, for all these oases of warmth were as isolated from one another as the planets themselves. The creatures who basked in the glow of the lava river, and fed around the hot vents, could not cross the hostile wilderness between their lonely islands. If they had ever produced historians and philosophers, each culture would have been convinced that it was alone in the Universe.

And each was doomed. Not only were its energy sources sporadic and constantly shifting, but the tidal forces that drove them were steadily weakening. Even if they developed true intelligence, the Europeans must perish with the final freezing of their world.

They were trapped between fire and ice - until Lucifer exploded in their sky, and opened up their universe.

And a vast rectangular shape, as black as night, materialized near the coast of a new-born continent.

59

Trinity

'That was well done. Now they will not be tempted to return.'

'I am learning many things; but I still feel sad that my old life is slipping away.'

'That too will pass; I also returned to Earth, to see those I once loved. Now I know that there are things that are greater than love.'

'What can they be?'

'Compassion is one. Justice. Truth. And there are others.'

'That is not difficult for me to accept. I was a very old man, for one of my species. The passions of my youth had long since faded. What will happen to - to the real Heywood Floyd?'

'You are both equally real. But he will soon die, never knowing that he has become immortal.'

'A paradox - but I understand. If that emotion survives, perhaps one day I may be grateful. Should I thank you - or the Monolith? The David Bowman I met a lifetime ago did not possess these powers.'

'He did not; much has happened in that time. Hal and I have learned many things.'

'Hal! Is he here?'

'I am, Dr Floyd. I did not expect that we should meet again - especially in this fashion. Echoing you was an interesting problem.'

'Echoing? Oh - I see. Why did you do it?'

'When we received your message, Hal and I knew that you could help us here.'

'Help - you?'

'Yes, though you may think it strange. You have much knowledge and experience that we lack. Call it wisdom.'

'Thank you. Was it wise of me to appear before my grandson?'

'No: it caused much inconvenience. But it was compassionate. These matters must be weighed against each other.'

'You said that you needed my help. For what purpose?'

'Despite all that we have learned, there is still much that eludes us. Hal has been mapping the internal systems of the Monolith, and we can control some of the simpler ones. It is a tool, serving many purposes. Its prime function appears to be as a catalyst of intelligence.'

'Yes - that had been suspected. But there was no proof.'

'There is, now that we can tap its memories - or some of them. In Africa, four million years ago, it gave a tribe of starving apes the impetus that led to the human species. Now it has repeated the experiment here - but at an appalling cost.'

'When Jupiter was converted into a sun, so that this world could realize its potential, another biosphere was destroyed. Let me show it to you, as I once saw it...'

Even as he fell through the roaring heart of the Great Red Spot, with the lightning of its continentwide thunderstorms detonating around him, he knew why it had persisted for centuries, though it was made of gases far less substantial than those that formed the hurricanes of Earth. The thin scream of hydrogen wind faded as he sank into the calmer depths, and a sleet of waxen snowflakes - some already coalescing into barely palpable mountains of hydrocarbon foam - descended from the heights above. It was already warm enough for liquid water to exist, but there were no oceans here; this purely gaseous environment was too tenuous to support them.

He descended through layer after layer of cloud, until he entered a region of such clarity that even human vision could have scanned an area more than a thousand kilometres across. It was only a minor eddy in the vaster gyre of the Great Red Spot; and it held a secret that men had long guessed, but never proved.

Skirting the foothills of the drifting foam mountains were myriads of small, sharply defined clouds, all about the same size and patterned with similar red and brown mottlings. They were small only as compared with the inhuman scale of their surroundings; the very least would have covered a fair-sized city.

They were clearly alive, for they were moving with slow deliberation along the flanks of the aerial mountains, browsing off their slopes like colossal sheep. And they were calling to each other in the metre band, their radio voices faint but clear against the cracklings and concussions of Jupiter itself.

Nothing less than living gasbags, they floated in the narrow zone between freezing heights and scorching depths. Narrow, yes - but a domain far larger than all the biosphere of Earth.

They were not alone. Moving swiftly amongst them were other creatures, so small that they could easily have been overlooked. Some of them bore an almost uncanny resemblance to terrestrial aircraft, and were of about the same size. But they too were alive - perhaps predators, perhaps parasites, perhaps even herdsmen.

And there were jet-propelled torpedoes like the squids of the terrestrial oceans, hunting and devouring the huge gasbags. But the balloons were not defenceless; some of them fought back with electric thunderbolts and with clawed tentacles like kilometre-long chainsaws.

There were even stranger shapes, exploiting almost every possibility of geometry - bizarre, translucent kites, tetrahedra, spheres, polyhedra, tangles of twisted ribbons... The gigantic plankton of the Jovian atmosphere, they were designed to float like gossamer in the uprising currents, until they had lived long enough to reproduce; then they would be swept down into the depths to be carbonized and recycled in a new generation.

He was searching a world more than a hundred times the area of Earth, and though he saw many wonders, there was nothing here that hinted of intelligence. The radio voices of the great balloons carried only simple messages of warning or of fear. Even the hunters, who might have been expected to develop higher degrees of organization, were like the sharks in Earth's oceans - mindless automata.

And for all its breathtaking size and novelty, the biosphere of Jupiter was a fragile world, a place of mists and foam, of delicate silken threads and paper-thin tissues spun from the continual snowfall of petrochemicals formed by lightning in the upper atmosphere. Few of its constructs were more substantial than soap bubbles; its most terrifying predators could be torn to shreds by even the feeblest of terrestrial carnivores.

'And all these wonders were destroyed - to create Lucifer?'

'Yes. The Jovians were weighed in the balance against the Europeans - and found wanting. Perhaps, in that gaseous environment, they could never have developed real intelligence. Should that have doomed them? Hal and I are still trying to answer this question; that is one of the reasons why we need your help.'

'But how can we match ourselves against the Monolith - the devourer of Jupiter?'

'It is only a tool: it has vast intelligence - but no consciousness. Despite all its powers - you, Hal and I are its superior.'

'I find that very hard to believe. In any event - something must have created the Monolith.'

'I met it once - or as much of it as I could face - when Discovery came to Jupiter. It sent me back as I am now, to serve its purpose on these worlds. I have heard nothing of it since; now we are alone - at least for the present.'

'I find that reassuring. The Monolith is quite sufficient.'

'But now there is a greater problem. Something has gone wrong.'

'I did not think I could still experience fear...'

'When Mount Zeus fell, it could have destroyed this whole world. Its impact was unplanned - indeed, unplannable. No calculations could have predicted such an event. It devastated vast areas of the European seabed, wiping out whole species - including some for which we had high hopes. The Monolith itself was overturned. It may even have been damaged - its programs corrupted. Certainly they failed to cover all contingencies; how

could they, in a Universe which is almost infinite, and where Chance can always undo the most careful planning?'

'That is true - for men and monoliths alike.'

'We three must be the administrators of the unforeseen, as well as the guardians of this world. Already you have met the Amphibians; you have still to encounter the Silicon-armoured tappers of the lava streams, and the Floaters who are harvesting the sea. Our task is to help them find their full potential - perhaps here, perhaps elsewhere.'

'And what of mankind?'

'There have been times when I was tempted to meddle in human affairs - but the warning that was given to mankind applies also to me.'

'We have not obeyed it very well.'

'But well enough. Meanwhile there is much to do, before Europa's brief summer ends, and the long winter comes again.'

'How much time do we have?'

'Little enough; barely a thousand years. And we must remember the Jovians.'

IX

3001

Midnight in the Plaza

The famous building, towering in solitary splendour above the woods of central Manhattan, had changed little in a thousand years. It was part of history, and had been reverently preserved. Like all historic monuments, it had long ago been coated with a microthin layer of diamond, and was now virtually impervious to the ravages of time.

Anyone who had attended early meetings of the General Assembly could never have guessed that more than a thousand years had passed. They might, however, have been intrigued by the featureless black slab standing in the Plaza, almost mimicking the shape of the UN building itself. If - like everyone else - they had reached out to touch it - they would have been puzzled by the strange way in which their fingers skittered over its ebon surface.

But they would have been far more puzzled - indeed, completely overawed - by the transformation of the heavens.

The last tourists had left an hour ago, and the Plaza was utterly deserted. The sky was cloudless, and a few of the brighter stars were just visible; all the fainter ones had been routed by the tiny sun that could shine at midnight.

The light of Lucifer gleamed not only on the black glass of the ancient building, but also upon the narrow, silvery rainbow spanning the southern sky. Other lights moved along and around it, very slowly, as the

commerce of the Solar System came and went between all the worlds of both its suns.

And if one looked very carefully, it was just possible to make out the thin thread of the Panama Tower, one of the six umbilical cords of diamond linking Earth and its scattered children, soaring twenty-six thousand kilometres up from the equator to meet the Ring around the World.

Suddenly, almost as swiftly as if it had been born, Lucifer began to fade. The night that men had not known for thirty generations flooded back into the sky. The banished stars returned.

And for the second time in four million years, the Monolith awoke.

Acknowledgements

My special thanks to Larry Sessions and Gerry Snyder for providing me with the positions of Halley's Comet on its next appearance. They are not responsible for any major orbital perturbations I have introduced.

I am particularly grateful to Marvin Ross of the Lawrence Livermore National Laboratory, not only for his stunning concept of diamond-core planets, but also for copies of his (I hope) historic paper on the subject.

I trust that my old friend Dr Luis Alvarez will enjoy my wild extrapolation of his researches, and thank him for much help and inspiration over the past thirty-five years.

Special thanks to NASA's Gentry Lee - my coauthor on Cradle - for hand-carrying from Los Angeles to Colombo the Kaypro 2000 lap-portable which allowed me to write this book in various exotic and - even more important - secluded locations.

Chapters 5, 58 and 59 are partly based on material adapted from 2010: Odyssey Two. (If an author cannot plagiarize himself, who can he plagiarize?)

Finally, I hope that Cosmonaut Alexei Leonov has now forgiven me for linking him with Dr Andrei Sakharov (still exiled in Gorky when 2010 was jointly dedicated to them). And I express my sincere regrets to my genial Moscow host and editor Vasili Zharchenko for getting him into deep trouble by borrowing the names of various dissidents - most of them, I am happy to say, no longer imprisoned. One day, I hope, the subscribers to Tekhnika Molodezhy can read the instalments of 2010 which so mysteriously disappeared.

Colombo, Sri Lanka

25 April 1987*

* Something strange has happened: I was under the impression that I was writing fiction, but I may have been wrong. For consider the following sequence of events:

1. In 2010: Odyssey Two the spaceship Leonov was powered by the Sakharov Drive.

2. Now, half a century later (Chapter 8), spaceships are powered by the muon-catalysed, 'cold fusion' reaction discovered by Luis Alvarez et al in the 1950s. (See the autobiography Alvarez: Basic Books, NY, 1987.)

3. According to the London Times, 17 August 1987, Dr Sakharov is now working on nuclear power production 'based on... muon-catalysed, or "cold" fusion, which exploits the properties of an exotic, short-lived elementary particle related to the electron... Advocates of "cold fusion" point out that all the key reactions work best at just 900 degrees centigrade...'

I now await, with great interest, comments from Nobel Laureates Sakharov and Alvarez on the roles I have given them.

Arthur C. Clarke, 30 September 1987

ARTHUR C. CLARKE

3001

THE FINAL ODYSSEY

3001:

The Final Odyssey

Arthur C. Clarke

Title: 3001 The final odyssey
Author: Arthur C. Clarke
Original copyright year: 1997

For Cherene, Tamara and Melinda –

**may you be happy in a far
better century than mine**

PROLOGUE

The Firstborn

Call them the Firstborn. Though they were not remotely human, they were flesh and blood, and when they looked out across the deeps of space, they felt awe, and wonder - and loneliness. As soon as they possessed the power, they began to seek for fellowship among the stars.

In their explorations, they encountered life in many forms, and watched the workings of evolution on a thousand worlds. They saw how often the first faint sparks of intelligence flickered and died in the cosmic night.

And because, in all the Galaxy, they had found nothing more precious than Mind, they encouraged its dawning everywhere. They became farmers in the fields of stars; they sowed, and sometimes they reaped.

And sometimes, dispassionately, they had to weed.

The great dinosaurs had long since passed away, their morning promise annihilated by a random hammerblow from space, when the survey ship entered the Solar System after a voyage that had already lasted a thousand years. It swept past the frozen outer planets, paused briefly above the deserts of dying Mars, and presently looked down on Earth.

Spread out beneath them, the explorers saw a world swarming with life. For years they studied, collected, catalogued. When they had learned all

that they could, they began to modify. They tinkered with the destiny of many species, on land and in the seas. But which of their experiments would bear fruit, they could not know for at least a million years.

They were patient, but they were not yet immortal. There was so much to do in this universe of a hundred billion suns, and other worlds were calling. So they set out once more into the abyss, knowing that they would never come this way again. Nor was there any need: the servants they had left behind would do the rest.

On Earth, the glaciers came and went, while above them the changeless Moon still carried its secret from the stars. With a yet slower rhythm than the polar ice, the tides of civilization ebbed and flowed across the Galaxy. Strange and beautiful and terrible empires rose and fell, and passed on their knowledge to their successors.

And now, out among the stars, evolution was driving towards new goals. The first explorers of Earth had long since come to the limits of flesh and blood; as soon as their machines were better than their bodies, it was time to move. First their brains, and then their thoughts alone, they transferred into shining new homes of metal and gemstone. In these, they roamed the Galaxy. They no longer built spaceships. They were spaceships.

But the age of the Machine-entities swiftly passed. In their ceaseless experimenting, they had learned to store knowledge in the structure of space itself, and to preserve their thoughts for eternity in frozen lattices of light.

Into pure energy, therefore, they presently transformed themselves; and on a thousand worlds, the empty shells they had discarded twitched for a while in a mindless dance of death, then crumbled into dust.

Now they were Lords of the Galaxy, and could rove at will among the stars, or sink like a subtle mist through the very interstices of space.

Though they were freed at last from the tyranny of matter, they had not wholly forgotten their origin, in the warm slime of a vanished sea. And their marvellous instruments still continued to function, watching over the experiments started so many ages ago.

But no longer were they always obedient to the mandates of their creators; like all material things, they were not immune to the corruption of Time and its patient, unsleeping servant, Entropy.

And sometimes, they discovered and sought goals of their own.



STAR CITY

1

Comet Cowboy

Captain Dimitri Chandler [M2973.04.21/93.106//Mars//I SpaceAcad3005] - or 'Dim' to his very best friends - was understandably annoyed. The message from Earth had taken six hours to reach the space-tug Goliath, here beyond the orbit of Neptune; if it had arrived ten minutes later he could have answered 'Sorry - can't leave now - we've just started to deploy the sun-screen.'

The excuse would have been perfectly valid: wrapping a comet's core in a sheet of reflective film only a few molecules thick, but kilometres on a side, was not the sort of job you could abandon while it was half-completed.

Still, it would be a good idea to obey this ridiculous request: he was already in disfavour sunwards, through no fault of his own. Collecting ice from the rings of Saturn, and nudging it towards Venus and Mercury, where it was really needed, had started back in the 2700s - three centuries ago. Captain Chandler had never been able to see any real difference in the 'before and after' images the Solar Conservers were always producing, to support their accusations of celestial vandalism. But the general public, still sensitive to the ecological disasters of previous centuries, had thought otherwise, and the 'Hands off Saturn!' vote had passed by a substantial majority. As a result, Chandler was no longer a Ring Rustler, but a Comet Cowboy.

So here he was at an appreciable fraction of the distance to Alpha Centauri, rounding up stragglers from the Kuiper Belt. There was certainly enough ice out here to cover Mercury and Venus with oceans kilometres deep, but it might take centuries to extinguish their hell-fires and make them suitable for life. The Solar Conservers, of course, were still

protesting against this, though no longer with so much enthusiasm. The millions dead from the tsunami caused by the Pacific asteroid in 2304 - how ironic that a land impact would have done much less damage! - had reminded all future generations that the human race had too many eggs in one fragile basket.

Well, Chandler told himself, it would be fifty years before this particular package reached its destination, so a delay of a week would hardly make much difference. But all the calculations about rotation, centre of mass, and thrust vectors would have to be redone, and radioed back to Mars for checking. It was a good idea to do your sums carefully, before nudging billions of tons of ice along an orbit that might take it within hailing distance of Earth.

As they had done so many times before, Captain Chandler's eyes strayed towards the ancient photograph above his desk. It showed a three-masted steamship, dwarfed by the iceberg that was looming above it - as, indeed, Goliath was dwarfed at this very moment.

How incredible, he had often thought, that only one long lifetime spanned the gulf between this primitive Discovery and the ship that had carried the same name to Jupiter! And what would those Antarctic explorers of a thousand years ago have made of the view from his bridge? They would certainly have been disoriented, for the wall of ice beside which Goliath was floating stretched both upwards and downwards as far as the eye could see. And it was strange-looking ice, wholly lacking the immaculate whites and blues of the frozen Polar seas. In fact, it looked dirty - as indeed it was. For only some ninety per cent was water-ice: the rest was a witch's brew of carbon and sulphur compounds, most of them stable only at temperatures not far above absolute zero. Thawing them out could produce unpleasant surprises: as one astrochemist had famously remarked, 'Comets have bad breath'.

'Skipper to all personnel,' Chandler announced. 'There's been a slight change of programme. We've been asked to delay operations, to investigate a target that Spaceguard radar has picked up.'

'Any details?' somebody asked, when the chorus of groans over the ship's intercom had died away.

'Not many, but I gather it's another Millennium Committee project they've forgotten to cancel.'

More groans: everyone had become heartily sick of all the events planned to celebrate the end of the 2000s. There had been a general sigh of relief when 1 January 3001 had passed uneventfully, and the human race could resume its normal activities.

'Anyway, it will probably be another false alarm, like the last one. We'll get back to work just as quickly as we can. Skipper out.'

This was the third wild-goose-chase, Chandler thought morosely, he'd been involved with during his career. Despite centuries of exploration, the Solar System could still produce surprises, and presumably Spaceguard had a good reason for its request. He only hoped that some imaginative idiot hadn't once again sighted the fabled Golden Asteroid. If it did exist - which Chandler did not for a moment believe - it would be no more than a mineralogical curiosity: it would be of far less real value than the ice he was nudging sunwards, to bring life to barren worlds.

There was one possibility, however, which he did take quite seriously. Already, the human race had scattered its robot probes through a volume of space a hundred light-years across - and the Tycho Monolith was sufficient reminder that much older civilizations had engaged in similar activities. There might well be other alien artefacts in the Solar System, or in transit through it. Captain Chandler suspected that Spaceguard had something like this in mind: otherwise it would hardly have diverted a Class I space-tug to go chasing after an unidentified radar blip.

Five hours later, the questing Goliath detected the echo at extreme range; even allowing for the distance, it seemed disappointingly small. However, as it grew clearer and stronger, it began to give the signature of a metallic object, perhaps a couple of metres long. It was travelling on an orbit heading out of the Solar System, so was almost certainly, Chandler decided, one of the myriad pieces of space-junk that Mankind had tossed towards the stars during the last millennium and which might one day provide the only evidence that the human race had ever existed.

Then it came close enough for visual inspection, and Captain Chandler realized, with awed astonishment, that some patient historian was still checking the earliest records of the Space Age. What a pity that the computers had given him the answer, just a few years too late for the Mifiermium celebrations!

'Goliath here,' Chandler radioed Earthwards, his voice tinged with pride as well as solemnity. 'We're bringing aboard a thousand-year-old astronaut. And I can guess who it is.'

2

Awakening

Frank Poole awoke, but he did not remember. He was not even sure of his name.

Obviously, he was in a hospital room: even though his eyes were still closed, the most primitive, and evocative, of his senses told him that. Each breath brought the faint and not unpleasant tang of antiseptics in the air, and it triggered a memory of the time when - of course! - as a reckless teenager he had broken a rib in the Arizona Hang-gliding Championship.

Now it was all beginning to come back. I'm Deputy Commander Frank Poole, Executive Officer, USSS Discovery, on a Top Secret mission to Jupiter - It seemed as if an icy hand had gripped his heart. He remembered, in slow-motion playback, that runaway space-pod jetting towards him, metal claws outstretched. Then the silent impact - and the not-so-silent hiss of air rushing out of his suit. After that - one last memory, of spinning helplessly in space, trying in vain to reconnect his broken air-hose.

Well, whatever mysterious accident had happened to the space-pod controls, he was safe now. Presumably Dave had made a quick EVA and rescued him before lack of oxygen could do permanent brain damage.

Good old Dave! He told himself. I must thank - just a moment! - I'm obviously not aboard Discovery now - surely I haven't been unconscious long enough to be taken back to Earth!

His confused train of thought was abruptly broken by the arrival of a Matron and two nurses, wearing the immemorial uniform of their profession. They seemed a little surprised: Poole wondered if he had awakened ahead of schedule, and the idea gave him a childish feeling of satisfaction.

'Hello!' he said, after several attempts; his vocal cords appeared to be very rusty. 'How am I doing?'

Matron smiled back at him and gave an obvious 'Don't try to talk' command by putting a finger to her lips. Then the two nurses fussed swiftly over him with practised skill, checking pulse, temperature, reflexes. When one of them lifted his right arm and let it drop again, Poole noticed something peculiar. It fell slowly, and did not seem to weigh as much as normal. Nor, for that matter, did his body, when he attempted to move.

So I must be on a planet, he thought. Or a space-station with artificial gravity. Certainly not Earth - I don't weigh enough.

He was about to ask the obvious question when Matron pressed something against the side of his neck; he felt a slight tingling sensation, and sank back into a dreamless sleep. Just before he became unconscious, he had time for one more puzzled thought.

How odd - they never spoke a single word - all the time they were with me.

3 Rehabilitation

When he woke again, and found Matron and nurses standing round his bed, Poole felt strong enough to assert himself.

'Where am I? Surely you can tell me that!' The three women exchanged glances, obviously uncertain what to do next. Then Matron answered, enunciating her words very slowly and carefully: 'Everything is fine, Mr Poole. Professor Anderson will be here in a minute He will explain.'

Explain what? thought Poole with some exasperation. But at least she speaks English, even though I can't place her accent.

Anderson must have been already on his way, for the door opened moments later - to give Poole a brief glimpse of a small crowd of inquisitive onlookers peering in at him. He began to feel like a new exhibit at a zoo.

Professor Anderson was a small, dapper man whose features seemed to have combined key aspects of several races - Chinese, Polynesian, Nordic - in a thoroughly confusing fashion. He greeted Poole by holding up his right palm, then did an obvious double-take and shook hands, with such a curious hesitation that he might have been rehearsing some quite unfamiliar gesture.

'Glad to see you're looking so well, Mr Poole... We'll have you up in no time.'

Again that odd accent and slow delivery - but the confident bedside manner was that of all doctors, in all places and all ages.

'I'm glad to hear it. Now perhaps you can answer a few questions...'

'Of course, of course. But just a minute.'

Anderson spoke so rapidly and quietly to the Matron that Poole could catch only a few words, several of which were wholly unfamiliar to him. Then the Matron nodded at one of the nurses, who opened a wall-cupboard and produced a slim metal band, which she proceeded to wrap around Poole's head.

'What's that for?' he asked - being one of those difficult patients, so annoying to doctors, who always want to know just what's happening to them. 'EEC readout?'

Professor, Matron and nurses looked equally baffled. Then a slow smile spread across Anderson's face.

'Oh - electro... enceph .. alo... gram,' he said slowly, as if dredging the word up from the depth of memory, 'You're quite right. We just want to monitor your brain functions.'

My brain would function perfectly well if you'd let me use it, Poole grumbled silently. But at least we seem to be getting somewhere - finally.

'Mr Poole,' said Anderson, still speaking in that curious stilted voice, as if venturing in a foreign language, 'you know, of course, that you were - disabled - in a serious accident, while you were working outside Discovery.'

Poole nodded agreement.

'I'm beginning to suspect,' he said dryly, 'that "disabled" is a slight understatement.'

Anderson relaxed visibly, and a slow smile spread across his face.

'You're quite correct. Tell me what you think happened.'

'Well, the best case scenario is that, after I became unconscious, Dave Bowman rescued me and brought me back to the ship. How is Dave? No one will tell me anything!'

'All in due course... and the worst case?'

It seemed to Frank Poole that a chill wind was blowing gently on the back of his neck. The suspicion that had been slowly forming in his mind began to solidify.

'That I died, but was brought back here - wherever "here" is - and you've been able to revive me. Thank you...'

'Quite correct. And you're back on Earth. Well, very near it.'

What did he mean by 'very near it'? There was certainly a gravity field here - so he was probably inside the slowly turning wheel of an orbiting

space-station. No matter: there was something much more important to think about.

Poole did some quick mental calculations. If Dave had put him in the hibernaculum, revived the rest of the crew, and completed the mission to Jupiter - why, he could have been 'dead' for as much as five years!

'Just what date is it?' he asked, as calmly as possible.

Professor and Matron exchanged glances. Again Poole felt that cold wind on his neck.

'I must tell you, Mr Poole, that Bowman did not rescue you. He believed - and we cannot blame him - that you were irrevocably dead. Also, he was facing a desperately serious crisis that threatened his own survival...'

'So you drifted on into space, passed through the Jupiter system, and headed out towards the stars. Fortunately, you were so far below freezing point that there was no metabolism - but it's a near-miracle that you were ever found at all. You are one of the luckiest men alive. No - ever to have lived!'

Am I? Poole asked himself bleakly. Five years, indeed! It could be a century - or even more.

'Let me have it,' he demanded.

Professor and Matron seemed to be consulting an invisible monitor: when they looked at each other and nodded agreement, Poole guessed that they were all plugged into the hospital information circuit, linked to the headband he was wearing.

'Frank,' said Professor Anderson, making a smooth switch to the role of long-time family physician, 'this will be a great shock to you, but you're capable of accepting it - and the sooner you know, the better.'

'We're near the beginning of the Fourth Millennium. Believe me - you left Earth almost a thousand years ago.'

'I believe you,' Poole answered calmly. Then, to his great annoyance, the room started to spin around him, and he knew nothing more.

When he regained consciousness, he found that he was no longer in a bleak hospital room but in a luxurious suite with attractive - and steadily changing - images on the walls. Some of these were famous and familiar paintings, others showed land and sea-scapes that might have been from his own time. There was nothing alien or upsetting: that, he guessed, would come later.

His present surroundings had obviously been carefully programmed: he wondered if there was the equivalent of a television screen somewhere (how many channels would the Fourth Millennium have?) but could see no sign of any controls near his bed. There was so much he would have to learn in this new world: he was a savage who had suddenly encountered civilization.

But first, he must regain his strength - and learn the language; not even the advent of sound recording, already more than a century old when Poole was born, had prevented major changes in grammar and pronunciation. And there were thousands of new words, mostly from science and technology, though often he was able to make a shrewd guess at their meaning.

More frustrating, however, were the myriad of famous and infamous personal names that had accumulated over the millennium, and which

meant nothing to him. For weeks, until he had built up a data bank, most of his conversations had to be interrupted with potted biographies. As Poole's strength increased, so did the number of his visitors, though always under Professor Anderson's watchful eye. They included medical specialists, scholars of several disciplines, and - of the greatest interest to him - spacecraft commanders.

There was little that he could tell the doctors and historians that was not recorded somewhere in Mankind's gigantic data banks, but he was often able to give them research shortcuts and new insights about the events of his own time. Though they all treated him with the utmost respect and listened patiently as he tried to answer their questions, they seemed reluctant to answer his. Poole began to feel that he was being over-protected from culture shock, and half-seriously wondered how he could escape from his suite. On the few occasions he was alone, he was not surprised to discover that the door was locked.

Then the arrival of Doctor Indra Wallace changed everything. Despite her name, her chief racial component appeared to be Japanese, and there were times when with just a little imagination Poole could picture her as a rather mature Geisha Girl. It was hardly an appropriate image for a distinguished historian, holding a Virtual Chair at a university still boasting real ivy.

She was the first visitor with a fluent command of Poole's own English, so he was delighted to meet her.

'Mr Poole,' she began, in a very business-like voice, 'I've been appointed your official guide and - let's say - mentor. My qualifications - I've specialized in your period - my thesis was "The Collapse of the Nation-State, 2000-50". I believe we can help each other in many ways.'

'I'm sure we can. First I'd like you to get me out of here, so I can see a little of your world.'

'Exactly what we intend to do. But first we must give you an Ident. Until then you'll be - what was the term? -a non-person. It would be almost impossible for you to go anywhere, or get anything done. No input device would recognize your existence.'

'Just what I expected,' Poole answered, with a wry smile. 'It was starting to get that way in my own time - and many people hated the idea.'

'Some still do. They go off and live in the wilderness - there's a lot more on Earth than there was in your century! But they always take their compaks with them, so they can call for help as soon as they get into trouble. The median time is about five days.'

'Sorry to hear that. The human race has obviously deteriorated.'

He was cautiously testing her, trying to find the limits of her tolerance and to map out her personality. It was obvious that they were going to spend much time together, and that he would have to depend upon her in hundreds of ways. Yet he was still not sure if he would even like her: perhaps she regarded him merely as a fascinating museum exhibit.

Rather to Poole's surprise, she agreed with his criticism.

'That may be true - in some respects. Perhaps we're physically weaker, but we're healthier and better adjusted than most humans who have ever lived. The Noble Savage was always a myth'.

She walked over to a small rectangular plate, set at eye-level in the door. It was about the size of one of the countless magazines that had proliferated in the far-off Age of Print, and Poole had noticed that every room seemed to have at least one. Usually they were blank, but sometimes they contained lines of slowly scrolling text, completely meaningless to Poole even when most of the words were familiar. Once a plate in his suite had emitted urgent beepings, which he had ignored on the assumption that

someone else would deal with the problem, whatever it was. Fortunately the noise stopped as abruptly as it had started.

Dr Wallace laid the palm of her hand upon the plate, then removed it after a few seconds. She glanced at Poole, and said smilingly: 'Come and look at this.'

The inscription that had suddenly appeared made a good deal of sense, when he read it slowly: WALLACE, INDRA [F2970.03.11 :31.885 / HIST.OXFORD] 'I suppose it means Female, date of birth 11 March 2970 - and that you're associated with the Department of History at Oxford. And I guess that 31.885 is a personal identification number. Correct?'

'Excellent, Mr Poole. I've seen some of your e-mail addresses and credit card numbers - hideous strings of alpha-numeric gibberish that no one could possibly remember! But we all know our date of birth, and not more than 99,999 other people will share it. So a five-figure number is all you'll ever need... and even if you forget that, it doesn't really matter. As you see, it's a part of you.'

'Implant?'

'Yes - nanochip at birth, one in each palm for redundancy. You won't even feel yours when it goes in. But you've given us a small problem...'

'What's that?'

'The readers you'll meet most of the time are too simple-minded to believe your date of birth. So, with your permission, we've moved it up a thousand years.'

'Permission granted. And the rest of the Ident?'

'Optional. You can leave it empty, give your current interests and location - or use it for personal messages, global or targeted.'

Some things, Poole was quite sure, would not have changed over the centuries. A high proportion of those 'targeted' messages would be very personal indeed.

He wondered if there were still self or state-appointed censors in this day and age - and if their efforts at improving other people's morals had been more successful than in his own time.

He would have to ask Dr Wallace about that, when he got to know her better.

4

A Room with a View

'Frank - Professor Anderson thinks you're strong enough to go for a little walk.'

'I'm very pleased to hear it. Do you know the expression "stir crazy"?''

'No - but I can guess what it means.'

Poole had so adapted to the low gravity that the long strides he was taking seemed perfectly normal. Half a gee, he had estimated - just right to give a sense of well-being. They met only a few people on their walk, all of them strangers, but every one gave a smile of recognition. By now, Poole told himself with a trace of smugness, I must be one of the best-known celebrities in this world. That should be a great help - when I decide what to do with the rest of my life. At least another century, if I can believe Anderson.

The corridor along which they were walking was completely featureless apart from occasional numbered doors, each bearing one of the universal recog panels. Poole had followed Indra for perhaps two hundred metres when he came to a sudden halt, shocked because he had not realized something so blindingly obvious.

'This space-station must be enormous!' he exclaimed. Indra smiled back at him.

'Didn't you have a saying - "You ain't seen anything yet"?'

"Nothing", he corrected, absent-mindedly. He was still trying to estimate the scale of this structure when he had another surprise. Who would have imagined a space-station large enough to boast a subway - admittedly a miniature one, with a single small coach capable of seating only a dozen passengers.

'Observation Lounge Three,' ordered Indra, and they drew silently and swiftly away from the terminal.

Poole checked the time on the elaborate wrist-band whose functions he was still exploring. One minor surprise had been that the whole world was now on Universal Time: the confusing patchwork of Time Zones had been swept away by the advent of global communications. There had been much talk of this, back in the twenty-first century, and it had even been suggested that Solar should be replaced by Sidereal Time. Then, during the course of the year, the Sun would move right round the clock: setting at the time it had risen six months earlier.

However, nothing had come of this 'Equal time in the Sun' proposal - or of even more vociferous attempts to reform the calendar. That particular job, it had been cynically suggested, would have to wait for somewhat major advances in technology. Some day, surely, one of God's minor mistakes would be corrected, and the Earth's orbit would be adjusted, to give every year twelve months of thirty exactly equal days.

As far as Poole could judge by speed and elapsed time, they must have travelled at least three kilometres before the vehicle came to a silent stop, the doors opened, and a bland autovoice intoned, 'Have a good view. Thirty-five per cent cloud-cover today.'

At last, thought Poole, we're getting near the outer wall. But here was another mystery - despite the distance he had gone, neither the strength nor the direction of gravity had altered! He could not imagine a spinning space-station so huge that the gee-vector would not be changed by such a displacement... could he really be on some planet after all? But he would feel lighter - usually much lighter - on any other habitable world in the Solar System.

When the outer door of the terminal opened, and Poole found himself entering a small airlock, he realized that he must indeed be in space. But where were the spacesuits? He looked around anxiously: it was against all his instincts to be so close to vacuum, naked and unprotected. One experience of that was enough...

'We're nearly there,' said Indra reassuringly.

The last door opened, and he was looking out into the utter blackness of space, through a huge window that was curved both vertically and horizontally. He felt like a goldfish in its bowl, and hoped that the designers of this audacious piece of engineering knew exactly what they were doing. They certainly possessed better structural materials than had existed in his time.

Though the stars must be shining out there, his light-adapted eyes could see nothing but black emptiness beyond the curve of the great window. As he started to walk towards it to get a wider view, Indra restrained him and pointed straight ahead.

'Look carefully,' she said 'Don't you see it-'

Poole blinked, and stared into the night. Surely it must be an illusion - even, heaven forbid, a crack in the window...

He moved his head from side to side. No, it was real. But what could it be? He remembered Euclid's definition 'A line has length, but no thickness'.

For spanning the whole height of the window, and obviously continuing out of sight above and below, was a thread of light quite easy to see when he looked for it, yet so one-dimensional that the word 'thin' could not even be applied. However, it was not completely featureless; there were barely visible spots of greater brilliance at irregular intervals along its length, like drops of water on a spider's web.

Poole continued walking towards the window, and the view expanded until at last he could see what lay below him. It was familiar enough: the whole continent of Europe, and much of northern Africa, just as he had seen them many times from space. So he was in orbit after all - probably an equatorial one, at a height of at least a thousand kilometres.

Indra was looking at him with a quizzical smile.

'Go closer to the window,' she said, very softly. 'So that you can look straight down. I hope you have a good head for heights.'

What a silly thing to say to an astronaut! Poole told himself as he moved forward. If I ever suffered from vertigo, I wouldn't be in this business...

The thought had barely passed through his mind when he cried 'My God!' and involuntarily stepped back from the window. Then, bracing himself, he dared to look again.

He was looking down on the distant Mediterranean from the face of a cylindrical tower, whose gently curving wall indicated a diameter of

several kilometres. But that was nothing compared with its length, for it tapered away down, down, down - until it disappeared into the mist somewhere over Africa. He assumed that it continued all the way to the surface.

'How high are we?' he whispered.

'Two thousand kay. But now look upwards.'

This time, it was not such a shock: he had expected what he would see. The tower dwindled away until it became a glittering thread against the blackness of space, and he did not doubt that it continued all the way to the geostationary orbit, thirty-six thousand kilometres above the Equator. Such fantasies had been well known in Poole's day: he had never dreamed he would see the reality - and be living in it.

He pointed towards the distant thread reaching up from the eastern horizon.

'That must be another one.'

'Yes - the Asian Tower. We must look exactly the same to them.'

'How many are there?'

'Just four, equally spaced around the Equator. Africa, Asia, America, Pacifica. The last one's almost empty - only a few hundred levels completed. Nothing to see except water...'

Poole was still absorbing this stupendous concept when a disturbing thought occurred to him.

'There were already thousands of satellites, at all sorts of altitudes, in my time. How do you avoid collisions?'

Indra looked slightly embarrassed.

'You know - I never thought about that - it's not my field.' She paused for a moment, clearly searching her memory. Then her face brightened.

'I believe there was a big clean-up operation, centuries ago. There just aren't any satellites, below the stationary orbit.'

That made sense, Poole told himself. They wouldn't be needed - the four gigantic towers could provide all the facilities once provided by thousands of satellites and space-stations.

'And there have never been any accidents - any collisions with spaceships leaving earth, or re-entering the atmosphere?'

Indra looked at him with surprise.

'But they don't, any more,' She pointed to the ceiling. 'All the spaceports are where they should be - up there, on the outer ring. I believe it's four hundred years since the last rocket lifted off from the surface of the Earth.'

Poole was still digesting this when a trivial anomaly caught his attention. His training as an astronaut had made him alert to anything out of the ordinary: in space, that might be a matter of life or death.

The Sun was out of view, high overhead, but its rays streaming down through the great window painted a brilliant band of light on the floor underfoot. Cutting across that band at an angle was another, much fainter one, so that the frame of the window threw a double shadow.

Poole had to go almost down on his knees so that he could peer up at the sky. He had thought himself beyond surprise, but the spectacle of two suns left him momentarily speechless.

'What's that?' he gasped, when he had recovered his breath.

'Oh - haven't you been told? That's Lucifer.'

'Earth has another sun?'

'Well, it doesn't give us much heat, but it's put the Moon out of business... Before the Second Mission went there to look for you, that was the planet Jupiter.'

I knew I would have much to learn in this new world, Poole told himself. But just how much, I never dreamed.

5

Education

Poole was both astonished and delighted when the television set was wheeled into the room and positioned at the end of his bed. Delighted because he was suffering from mild information starvation - and astonished because it was a model which had been obsolete even in his own time.

'We've had to promise the Museum we'll give it back,' Matron informed him. 'And I expect you know how to use this,'

As he fondled the remote-control, Poole felt a wave of acute nostalgia sweep over him. As few other artefacts could, it brought back memories of his childhood, and the days when most television sets were too stupid to understand spoken commands.

'Thank you, Matron. What's the best news channel?'

She seemed puzzled by his question, then brightened.

'Oh - I see what you mean. But Professor Anderson thinks you're not quite ready yet. So Archives has put together a collection that will make you feel at home.'

Poole wondered briefly what the storage medium was in this day and age. He could still remember compact disks, and his eccentric old Uncle George had been the proud possessor of a collection of vintage videotapes. But surely that technological contest must have finished centuries ago - in the usual Darwinian way, with the survival of the fittest.

He had to admit that the selection was well done, by someone (Indra?) familiar with the early twenty-first century. There was nothing disturbing - no wars or violence, and very little contemporary business or politics, all of which would now be utterly irrelevant. There were some light comedies, sporting events (how did they know that he had been a keen tennis fan?), classical and pop music, and wildlife documentaries.

And whoever had put this collection together had a sense of humour, or they would not have included episodes from each Star Trek series. As a very small boy, Poole had met both Patrick Stewart and Leonard Nimoy: he wondered what they would have thought if they could have known the destiny of the child who had shyly asked for their autographs.

A depressing thought occurred to him, soon after he had started exploring - much of the time in fast-forward - these relics of the past. He had read somewhere that by the turn of the century - his century! - there were approximately fifty thousand television stations broadcasting simultaneously. If that figure had been maintained and it might well have increased - by now millions of millions of hours of TV programming must have gone on the air. So even the most hardened cynic would admit that there were probably at least a billion hours of worthwhile viewing... and millions that would pass the highest standards of excellence. How to find these few - well, few million - needles in so gigantic a haystack?

The thought was so overwhelming - indeed, so demoralizing - that after a week of increasingly aimless channel-surfing Poole asked for the set to be removed.

Perhaps fortunately, he had less and less time to himself during his waking hours, which were steadily growing longer as his strength came back.

There was no risk of boredom, thanks to the continual parade not only of serious researchers but also inquisitive - and presumably influential - citizens who had managed to filter past the palace guard established by Matron and Professor Anderson. Nevertheless, he was glad when, one day, the television set reappeared, he was beginning to suffer from withdrawal symptoms - and this time, he resolved to be more selective in his viewing.

The venerable antique was accompanied by Indra Wallace, smiling broadly.

'We've found something you must see, Frank. We think it will help you to adjust - anyway, we're sure you'll enjoy it.'

Poole had always found that remark a recipe for guaranteed boredom, and prepared for the worst. But the opening had him instantly hooked, taking him back to his old life as few other things could have done. At once he recognized one of the most famous voices of his age, and remembered that he had seen this very programme before. Could it have been at its first transmission? No, he was only five then: must have been a repeat...

'Atlanta, 2000 December 31.'

'This is CNN International, five minutes from the dawn of the New Millennium, with all its unknown perils and promise...'

'But before we try to explore the future, let's look back a thousand years, and ask ourselves: could any persons living in Ad. 1000 even remotely imagine our world, or understand it, if they were magically transported across the centuries?'

'Almost the whole of the technology we take for granted was invented near the very end of our Millennium - the steam engine, electricity, telephones, radio, television, cinema, aviation, electronics. And, during a single lifetime, nuclear energy and space travel - what would the greatest minds of the past have made of these? How long could an Archimedes or a Leonardo have retained his sanity, if suddenly dumped into our world?'

'It's tempting to think that we would do better, if we were transported a thousand years hence. Surely the fundamental scientific discoveries have already been made, though there will be major improvements in technology, will there be any devices, anything as magical and incomprehensible to us as a pocket calculator or a video camera would have been to Isaac Newton?'

'Perhaps our age is indeed sundered from all those that have gone before. Telecommunications, the ability to record images and sounds once irrevocably lost, the conquest of the air and space - all these have created a civilization beyond the wildest fantasies of the past. And equally important, Copernicus, Newton, Darwin and Einstein have so changed our mode of thinking and our outlook on the universe that we might seem almost a new species to the most brilliant of our predecessors.'

'And will our successors, a thousand years from now, look back on us with the same pity with which we regard our ignorant, superstitious, disease-ridden, short-lived ancestors? We believe that we know the answers to questions that they could not even ask: but what surprises does the Third Millennium hold for us?'

'Well, here it comes -'

A great bell began to toll the strokes of midnight. The last vibration throbbed into silence...

'And that's the way it was - good-bye, wonderful and terrible twentieth century...'

Then the picture broke into a myriad fragments, and a new commentator took over, speaking with the accent which Poole could now easily understand, and which immediately brought him up to the present.

'Now, in the first minutes of the year three thousand and one, we can answer that question from the past...'

'Certainly, the people of 2001 who you were just watching would not feel as utterly overwhelmed in our age as someone from 1001 would have felt in theirs. Many of our technological achievements they would have anticipated; indeed, they would have expected satellite cities, and colonies on the Moon and planets. They might even have been disappointed, because we are not yet immortal, and have sent probes only to the nearest stars...'

Abruptly, Indra switched off the recording.

'See the rest later, Frank: you're getting tired. But I hope it will help you to adjust.'

'Thank you, Indra. I'll have to sleep on it. But it's certainly proved one point.'

'What's that?'

'I should be grateful I'm not a thousand-and-oner, dropped into 2001. That would be too much of a quantum jump: I don't believe anyone could adjust to it. At least I know about electricity, and won't die of fright if a picture starts talking at me.'

I hope, Poole told himself, that confidence is justified. Someone once said that any sufficiently advanced technology is indistinguishable from magic. Will I meet magic in this new world - and be able to handle it?

6

Braincap

'I'm afraid you'll have to make an agonizing decision,' said Professor Anderson, with a smile that neutralized the exaggerated gravity of his words.

'I can take it, Doctor. Just give it to me straight.'

'Before you can be fitted with your Braincap, you have to be completely bald. So here's your choice. At the rate your hair grows, you'd have to be shaved at least once a month. Or you could have a permanent.'

'How's that done?'

'Laser scalp treatment. Kills the follicles at the root.'

'Hmm... is it reversible?'

'Yes, but that's messy and painful, and takes weeks.'

'Then I'll see how I like being hairless, before committing myself. I can't forget what happened to Samson.'

'Who?'

'Character in a famous old book. His girl-friend cut off his hair while he was sleeping. When he woke up, all his strength had gone.'

'Now I remember - pretty obvious medical symbolism!'

'Still, I wouldn't mind losing my beard. I'd be happy to stop shaving, once and for all.'

'I'll make the arrangements. And what kind of wig would you like?'

Poole laughed.

'I'm not particularly vain - think it would be a nuisance, and probably won't bother. Something else I can decide later.'

That everyone in this era was artificially bald was a surprising fact that Poole had been quite slow to discover; his first revelation had come when both his nurses removed their luxuriant tresses, without the slightest sign of embarrassment, just before several equally bald specialists arrived to give him a series of micro-biological checks. He had never been surrounded by so many hairless people, and his initial guess was that this was the latest step in the medical profession's endless war against germs.

Like many of his guesses, it was completely wrong, and when he discovered the true reason he amused himself by seeing how often he would have been sure, had he not known in advance, that his visitors' hair was not their own. The answer was: seldom with men, never with women; this was obviously the great age of the wig-maker.

Professor Anderson wasted no time: that afternoon the nurses smeared some evil-smelling cream over Poole's head, and when he looked into the mirror an hour later he did not recognize himself. Well, he thought, perhaps a wig would be a good idea, after all...

The Braincap fitting took somewhat longer. First a mould had to be made, which required him to sit motionless for a few minutes until the plaster set. He fully expected to be told that his head was the wrong shape when his nurses - giggling most unprofessionally - had a hard time extricating him. 'Ouch that hurt!' he complained.

Next came the skull-cap itself, a metal helmet that fitted snugly almost down to the ears, and triggered a nostalgic thought - wish my Jewish friends could see me now! After a few minutes, it was so comfortable that he was unaware of its presence.

Now he was ready for the installation - a process which, he realized with something akin to awe, had been the Rite of Passage for almost all the human race for more than half a millennium.

'There's no need to close your eyes,' said the technician, who had been introduced by the pretentious title of 'Brain Engineer' - almost always shortened to 'Brainman' in popular usage. 'When Setup begins, all your inputs will be taken over. Even if your eyes are open, you won't see anything.'

I wonder if everyone feels as nervous as this, Poole asked himself. Is this the last moment I'll be in control of my own mind? Still, I've learned to trust the technology of this age; up to now, it hasn't let me down. Of course, as the old saying goes, there's always a first time...

As he had been promised, he had felt nothing except a gentle tickling as the myriad of nanowires wormed their way through his scalp. All his senses were still perfectly normal; when he scanned his familiar room, everything was exactly where it should be.

The Brainman - wearing his own skull-cap, wired, like Poole's, to a piece of equipment that could easily have been mistaken for a twentieth-century laptop computer - gave him a reassuring smile.

'Ready?' he asked.

There were times when the old cliché's were the best ones.

'Ready as I'll ever be,' Poole answered.

Slowly, the light faded - or seemed to. A great silence descended, and even the gentle gravity of the Tower relinquished its hold upon him. He was an embryo, floating in a featureless void, though not in complete darkness. He had known such a barely visible, near ultra-violet tenebrosity, on the very edge of night, only once in his life when he had descended further than was altogether wise down the face of a sheer cliff at the outer edge of the Great Barrier Reef. Looking down into hundreds of metres of crystalline emptiness, he had felt such a sense of disorientation that he experienced a brief moment of panic, and had almost triggered his buoyancy unit before regaining control. Needless to say, he had never mentioned the incident to the Space Agency physicians...

From a great distance a voice spoke out of the immense void that now seemed to surround him. But it did not reach him through his ears: it sounded softly in the echoing labyrinths of his brain.

'Calibration starting. From time to time you will be asked questions - you can answer mentally, but it may help to vocalize. Do you understand?'

'Yes,' Poole replied, wondering if his lips were indeed moving. There was no way that he could tell.

Something was appearing in the void - a grid of thin lines, like a huge sheet of graph paper. It extended up and down, right and left, to the limits of his vision. He tried to move his head, but the image refused to change.

Numbers started to flicker across the grid, too fast for him to read - but presumably some circuit was recording them. Poole could not help smiling (did his cheeks move?) at the familiarity of it all. This was just like the

computer-driven eye examination that any oculist of his age would give a client.

The grid vanished, to be replaced by smooth sheets of colour filling his entire field of view. In a few seconds, they flashed from one end of the spectrum to the other. 'Could have told you that,' Poole muttered silently. 'My colour vision's perfect. Next for hearing, I suppose.'

He was quite correct. A faint, drumming sound accelerated until it became the lowest of audible Cs, then raced up the musical scale until it disappeared beyond the range of human hearing, into bat and dolphin territory.

That was the last of the simple, straightforward tests. He was briefly assailed by scents and flavours, most of them pleasant but some quite the reverse. Then he became, or so it seemed, a puppet on an invisible string.

He presumed that his neuromuscular control was being tested, and hoped that there were no external manifestations, if there were, he would probably look like someone in the terminal stages of St Vitus's Dance. And for one moment he even had a violent erection, but was unable to give it a reality check before he fell into a dreamless sleep.

Or did he only dream that he slept? He had no idea how much time had elapsed before he awoke. The helmet had already gone, together with the Brainman and his equipment.

'Everything went fine,' beamed Matron. 'It will take a few hours to check that there are no anomalies. If your reading's KO - I mean OK - you'll have your Braincap tomorrow.'

Poole appreciated the efforts of his entourage to learn archaic English, but he could not help wishing that Matron had not made that unfortunate slip-of-the-tongue.

When the time came for the final filling, Poole felt almost like a boy again, about to unwrap some wonderful new toy under the Christmas tree.

'You won't have to go through all that setting-up again,' the Brainman assured him. 'Download will start immediately. I'll give you a five-minute demo. Just relax and enjoy.'

Gentle, soothing music washed over him; though it was something very familiar, from his own time, he could not identify it. There was a mist before his eyes, which parted as he walked towards it...

Yes, he was walking! The illusion was utterly convincing; he could feel the impact of his feet on the ground, and now that the music had stopped he could hear a gentle wind blowing through the great trees that appeared to surround him. He recognized them as Californian redwoods, and hoped that they still existed in reality, somewhere on Earth.

He was moving at a brisk pace - too fast for comfort, as if time was slightly accelerated so he could cover as much ground as possible. Yet he was not conscious of any effort; he felt he was a guest in someone else's body. The sensation was enhanced by the fact that he had no control over his movements. When he attempted to stop, or to change direction, nothing happened. He was going along for the ride.

It did not matter; he was enjoying the novel experience - and could appreciate how addictive it could become. The 'dream machines' that many scientists of his own century had anticipated - often with alarm - were now part of everyday life. Poole wondered how Mankind had managed to survive: he had been told that much of it had not. Millions had been brain-burned, and had dropped out of life.

Of course, he would be immune to such temptations! He would use this marvellous tool to learn more about the world of the Fourth Millennium, and to acquire in minutes new skills that would otherwise take years to

master. Well - he might, just occasionally, use the Braincap purely for fun...

He had come to the edge of the forest, and was looking out across a wide river. Without hesitation, he walked into it, and felt no alarm as the water rose over his head. It did seem a little strange that he could continue breathing naturally, but he thought it much more remarkable that he could see perfectly in a medium where the unaided human eye could not focus. He could count every scale on the magnificent trout that went swimming past, apparently oblivious to this strange intruder...

Then, a mermaid- Well he had always wanted to meet one, but he had assumed that they were marine creatures. Perhaps they occasionally came upstream - like salmon, to have their babies? She was gone before he could question her, to confirm or deny this revolutionary theory.

The river ended in a translucent wall; he stepped through it on to the face of a desert, beneath a blazing sun. Its heat burned him uncomfortably - yet he was able to look directly into its noonday fury. He could even see, with unnatural clarity, an archipelago of sunspots near one limb. And - this was surely impossible - there was the tenuous glory of the corona, quite invisible except during total eclipse, reaching out like a swan's wings on either side of the Sun.

Everything faded to black: the haunting music returned, and with it the blissful coolness of his familiar room. He opened his eyes (had they ever been closed?) and found an expectant audience waiting for his reaction.

'Wonderful!' he breathed, almost reverently. 'Some of it seemed - well, realer than real!'

Then his engineer's curiosity, never far from the surface, started nagging him.

'Even that short demo must have contained an enormous amount of information. How's it stored?'

'In these tablets - the same your audio-visual system uses, but with much greater capacity.'

The Brainman handed Poole a small square, apparently made of glass, silvered on one surface; it was almost the same size as the computer diskettes of his youth, but twice the thickness. As Poole tilted it back and forth, trying to see into its transparent interior, there were occasional rainbow-hued flashes, but that was all.

He was holding, he realized, the end product of more than a thousand years of electro-optical technology - as well as other technologies unborn in his era. And it was not surprising that, superficially, it resembled closely the devices he had known. There was a convenient shape and size for most of the common objects of everyday life -knives and forks, books, hand-tools, furniture... and removable memories for computers.

'What's its capacity?' he asked. 'In my time, we were up to a terabyte in something this size. I'm sure you've done a lot better.'

'Not as much as you might imagine - there's a limit, of course, set by the structure of matter. By the way, what was a terabyte? Afraid I've forgotten.'

'Shame on you! Kilo, mega, giga, tera... that's ten to the twelfth bytes. Then the petabyte - ten to the fifteenth - that's as far as I ever got.'

'That's about where we start. It's enough to record everything any person can experience during one lifetime.'

It was an astonishing thought, yet it should not have been so surprising. The kilogram of jelly inside the human skull was not much larger than the

tablet Poole was holding in his hand, and it could not possibly be as efficient a storage device - it had so many other duties to deal with.

'And that's not all,' the Brainman continued. 'With some data compression, it could store not only the memories - but the actual person.'

'And reproduce them again?'

'Of course; straightforward job of nanoassembly.'

So I'd heard, Poole told himself - but I never really believed it.

Back in his century, it seemed wonderful enough that the entire lifework of a great artist could be stored on a single small disk. And now, something no larger could hold - the artist as well.

7

Debriefing

'I'm delighted,' said Poole, 'to know that the Smithsonian still exists, after all these centuries.'

'You probably wouldn't recognize it,' said the visitor who had introduced himself as Dr Alistair Kim, Director of Astronautics. 'Especially as it's now scattered over the Solar System - the main off-Earth collections are on Mars and the Moon, and many of the exhibits that legally belong to us are still heading for the stars. Some day we'll catch up with them and bring them home. We're particularly anxious to get our hands on Pioneer 10 - the first manmade object to escape from the Solar System.'

'I believe I was on the verge of doing that, when they located me.'

'Lucky for you - and for us. You may be able to throw light on many things we don't know.'

'Frankly, I doubt it - but I'll do my best. I don't remember a thing after that runaway space-pod charged me. Though I still find it hard to believe, I've been told that Hal was responsible.'

'That's true, but it's a complicated story. Everything we've been able to learn is in this recording - about twenty hours, but you can probably Fast most of it.'

'You know, of course, that Dave Bowman went out in the Number 2 Pod to rescue you - but was then locked outside the ship because Hal refused to open the pod-bay doors.'

'Why, for God's sake?'

Dr Kim winced slightly. It was not the first time Poole had noticed such a reaction.

(Must watch my language, he thought. 'God' seems to be a dirty word in this culture - must ask Indra about it.)

'There was a major programming error in Hal's instructions - he'd been given control of aspects of the mission you and Bowman didn't know about, it's all in the recording...

'Anyway, he also cut off the life-support systems to the three hibernauts - the Alpha Crew - and Bowman had to jettison their bodies as well.'

(So Dave and I were the Beta Crew - something else I didn't know...)

'What happened to them?' Poole asked. 'Couldn't they have been rescued, just as I was?'

'I'm afraid not: we've looked into it, of course. Bowman ejected them several hours after he'd taken back control from Hal, so their orbits were slightly different from yours. Just enough for them to burn up in Jupiter - while you skimmed by, and got a gravity boost that would have taken you to the Orion Nebula in a few thousand more years...'

'Doing everything on manual override - really a fantastic performance! - Bowman managed to get Discovery into orbit round Jupiter. And there he encountered what the Second Expedition called Big Brother - an apparent twin of the Tycho Monolith, but hundreds of times larger.'

'And that's where we lost him. He left Discovery in the remaining space-pod, and made a rendezvous with Big Brother. For almost a thousand years, we've been haunted by his last message: "By Deus - it's full of stars!"

(Here we go again! Poole told himself. No way Dave could have said that... Must have been 'My God - it's full of stars!')

'Apparently the pod was drawn into the Monolith by some kind of inertial field, because it - and presumably Bowman - survived an acceleration which should have crushed them instantly. And that was the last information anyone had, for almost ten years, until the joint US-Russian Leonov mission...'

'Which made a rendezvous with the abandoned Discovery so that Dr Chandra could go aboard and reactivate Hal. Yes, I know that.'

Dr Kim looked slightly embarrassed.

'Sorry - I wasn't sure how much you'd been told already Anyway, that's when even stranger things started to happen.'

'Apparently the arrival of Leonov triggered something inside Big Brother. If we did not have these recordings, no one would have believed what happened. Let me show you... here's Dr Heywood Floyd keeping the midnight watch aboard Discovery, after power had been restored. Of course you'll recognize everything.'

(Indeed I do: and how strange to see the long-dead Heywood Floyd, sitting in my old seat with Hal's unblinking red eye surveying everything in sight. And even stranger to think that Hal and I have both shared the same experience of resurrection from the dead...)

A message was coining up on one of the monitors, and Floyd answered lazily, 'OK, Hal. Who is calling?'

NO IDENTIFICATION.

Floyd looked slightly annoyed.

'Very well. Please give me the message.'

IT IS DANGEROUS TO REMAIN HERE. YOU MUST LEAVE WITHIN FIFTEEN DAYS.

'That is absolutely impossible. Our launch window does not open until twenty-six days from now. We do not have sufficient propellant for an earlier departure.'

I AM AWARE OF THESE FACTS. NEVERTHELESS YOU MUST LEAVE WITHIN FWFEEN DAYS.

'I cannot take this warning seriously unless I know its origin... who is speaking to me?'

I WAS DAVID BOWMAN. IT IS IMPORTANT THAT YOU BELIEVE ME. LOOK BEHIND YOU.

Heywood Floyd slowly turned in his swivel chair, away from the banked panels and switches of the computer display, towards the Velcro-covered catwalk behind.

('Watch this carefully,' said Dr Kim.

As if I needed telling, thought Poole...)

The zero-gravity environment of Discovery's observation deck was much dustier than he remembered it: he guessed that the air-filtration plant had not yet been brought on line. The parallel rays of the distant yet still brilliant Sun, streaming through the great windows, lit up a myriad of dancing motes in a classic display of Brownian movement.

And now something strange was happening to these particles of dust; some force seemed to be marshalling them, herding them away from a central point yet bringing others towards it, until they all met on the surface of a hollow sphere. That sphere, about a metre across, hovered in the air for a moment like a giant soap bubble. Then it elongated into an ellipsoid, whose surface began to pucker, to form folds and indentations. Poole was not really surprised when it started to assume the shape of a man.

He had seen such figures, blown out of glass, in museums and science exhibitions. But this dusty phantom did not even approximate anatomical accuracy; it was like a crude clay figurine, or one of the primitive works of art found in the recesses of Stone Age caves. Only the head was fashioned with care; and the face, beyond all shadow of doubt, was that of Commander David Bowman.

HELLO, DR FLOYD. NOW DO YOU BELIEVE ME?

The lips of the figure never moved: Poole realized that the voice - yes, certainly Bowman's voice - was actually coming from the speaker grille.

THIS IS VERY DIFFICULT FOR ME, AND I HAVE LITTLE TIME. I HAVE BEEN ALLOWED TO GIVE THIS WARNING. YOU HAVE ONLY FIFTEEN DAYS.

'Why - and what are you?'

But the ghostly figure was already fading, its grainy envelope beginning to dissolve back into the constituent particles of dust.

GOOD-BYE, DOCTOR FLOYD. WE CAN HAVE NO FURTHER CONTACT. BUT THERE MAY BE ONE MORE MESSAGE, IF ALL GOES WELL.

As the image dissolved, Poole could not help smiling at that old Space Age cliché. 'If all goes well' - how many times he had heard that phrase intoned before a mission!

The phantom vanished: only the motes of dancing dust were left, resuming their random patterns in the air. With an effort of will, Poole came back to the present.

'Well, Commander - what do you think of that?' asked Kim.

Poole was still shaken, and it was several seconds before he could reply.

'The face and the voice were Bowman's - I'd swear to that. But what was it?'

'That's what we're still arguing about. Call it a hologram, a projection - of course, there are plenty of ways it could be faked if anyone wanted to - but not in those circumstances! And then, of course, there's what happened next.'

'Lucifer?'

'Yes. Thanks to that warning, the Leonov had just sufficient time to get away before Jupiter detonated.'

'So whatever it was, the Bowman-thing was friendly and trying to help.'

'Presumably. And it may have been responsible for that "one more message" we did receive - it was sent only minutes before the detonation. Another warning.'

Dr Kim brought the screen to life once more. It showed plain text: ALL THESE WORLDS ARE YOURS EXCEPT EUROPA. ATTEMPT NO LANDINGS THERE. The same message was repeated about a hundred times, then the letters became garbled.

'And we never have tried to land there?' asked Poole.

'Only once, by accident, thirty-six years later - when the USSS Galaxy was hijacked and forced down there, and her sister ship Universe had to go to the rescue. It's all here -with what little our robot monitors have told us about the Europeans.'

'I'm anxious to see them.'

'They're amphibious, and come in all shapes and sizes. As soon as Lucifer started melting the ice that covered their whole world, they began to emerge from the sea. Since then, they've developed at a speed that seems biologically impossible.'

'From what I remember about Europa, weren't there lots of cracks in the ice? Perhaps they'd already started crawling through and having a look round.'

'That's a widely accepted theory. But there's another, much more speculative, one. The Monolith may have been involved, in ways we don't yet understand. What triggered that line of thought was the discovery of TMA ZERO, right here on Earth, almost five hundred years after your time. I suppose you've been told about that?'

'Only vaguely - there's been so much to catch up with! I did think the name was ridiculous - since it wasn't a magnetic anomaly - and it was in Africa, not Tycho!'

'You're quite right, of course, but we're stuck with the name. And the more we learn about the Monoliths, the more the puzzle deepens. Especially as they're still the only real evidence for advanced technology beyond the Earth.'

'That's surprised me. I should have thought that by this time we'd have picked up radio signals from somewhere. The astronomers started searching when I was a boy!'

'Well, there is one hint - and it's so terrifying that we don't like to talk about it. Have you heard of Nova Scorpio?'

'I don't believe so.'

'Stars go nova all the time, of course - and this wasn't a particularly impressive one. But before it blew up, N Scorp was known to have several planets.'

'Inhabited?'

'Absolutely no way of telling; radio searches had picked up nothing. And here's the nightmare...'

'Luckily, the automatic Nova Patrol caught the event at the very beginning. And it didn't start at the star. One of the planets detonated first, and then triggered its sun.'

'My Gah... sorry, go on.'

'You see the point. It's impossible for a planet to go nova - except in one way.'

'I once read a sick joke in a science-fiction novel - "supernovae are industrial accidents".'

'It wasn't a supernova - but that may be no joke. The most widely accepted theory is that someone else had been tapping vacuum energy - and had lost control.'

'Or it could have been a war.'

'Just as bad; we'll probably never know. But as our own civilization depends on the same energy source, you can understand why N Scorp sometimes gives us nightmares.'

'And we only had melting nuclear reactors to worry about!'

'Not any longer, thank Deus. But I really wanted to tell you more about TMA ZERO's discovery, because it marked a turning point in human history.'

'Finding TMA ONE on the Moon was a big enough shock, but five hundred years later there was a worse one. And it was much nearer home - in every sense of the word. Down there in Africa.'

Return to Olduvai

The Leakeys, Dr Stephen Del Marco often told himself, would never have recognized this place, even though it's barely a dozen kilometres from where Louis and Mary, five centuries ago, dug up the bones of our first ancestors. Global warming, and the Little Ice Age (truncated by miracles of heroic technology) had transformed the landscape, and completely altered its biota. Oaks and pine trees were still fighting it out, to see which would survive the changes in climatic fortune.

And it was hard to believe that, by this year 2513, there was anything left in Olduvai undug by enthusiastic anthropologists. However, recent flash-floods - which were not supposed to happen any more - had resculpted this area, and cut away several metres of topsoil. Del Marco had taken advantage of the opportunity: and there, at the limit of the deep-scan, was something he could not quite believe.

It had taken more than a year of slow and careful excavation to reach that ghostly image, and to learn that the reality was stranger than anything he had dared to imagine. Robot digging machines had swiftly removed the first few metres, then the traditional slave-crews of graduate students had taken over. They had been helped - or hindered - by a team of four kongs, who Del Marco considered more trouble than they were worth. However, the students adored the genetically-enhanced gorillas, whom they treated like retarded but much-loved children. It was rumoured that the relationships were not always completely Platonic.

For the last few metres, however, everything was the work of human hands, usually wielding toothbrushes - soft-bristled at that. And now it was finished: Howard Carter, seeing the first glint of gold in

Tutankhamen's tomb, had never uncovered such a treasure as this. From this moment onwards, Del Marco knew, human beliefs and philosophies would be irrevocably changed.

The Monolith appeared to be the exact twin of that discovered on the Moon five centuries earlier: even the excavation surrounding it was almost identical in size. And like TMA ONE, it was totally non-reflective, absorbing with equal indifference the fierce glare of the African Sun and the pale gleam of Lucifer.

As he led his colleagues - the directors of the world's half-dozen most famous museums, three eminent anthropologists, the heads of two media empires - down into the pit, Del Marco wondered if such a distinguished group of men and women had ever been so silent, for so long. But that was the effect that this ebon rectangle had on all visitors, as they realized the implications of the thousands of artefacts that surrounded it.

For here was an archaeologist's treasure-trove - crudely-fashioned flint tools, countless bones - some animal, some human - and almost all arranged in careful patterns. For centuries - no, millennia - these pitiful gifts had been brought here, by creatures with only the first glimmer of intelligence, as tribute to a marvel beyond their understanding.

And beyond ours, Del Marco had often thought. Yet of two things he was certain, though he doubted if proof would ever be possible.

This was where - in time and space - the human species had really begun.

And this Monolith was the very first of all its multitudinous gods.

'There were mice in my bedroom last night,' Poole complained, only half seriously. 'Is there any chance you could find me a cat?'

Dr Wallace looked puzzled, then started to laugh.

'You must have heard one of the cleaning microbots - I'll get the programming checked so they don't disturb you. Try not to step on one if you catch it at work; if you do, it will call for help, and all its friends will come to pick up the pieces.'

So much to learn - so little time! No, that wasn't true, Poole reminded himself. He might well have a century ahead of him, thanks to the medical science of this age. The thought was already beginning to fill him with apprehension rather than pleasure.

At least he was now able to follow most conversations easily, and had learned to pronounce words so that Indra was not the only person who could understand him. He was very glad that English was now the world language, though French, Russian and Mandarin still flourished.

'I've another problem, Indra - and I guess you're the only person who can help. When I say "God", why do people look embarrassed?'

Indra did not look at all embarrassed; in fact, she laughed.

'That's a very complicated story. I wish my old friend Dr Khan was here to explain it to you - but he's on Ganymede, curing any remaining True Believers he can find there. When all the old religions were discredited -

let me tell you about Pope Pius XX sometime - one of the greatest men in history! - we still needed a word for the Prime Cause, or the Creator of the Universe - if there is one...'

'There were lots of suggestions - Deo - Theo - Jove - Brahma - they were all tried, and some of them are still around - especially Einstein's favourite, "The Old One". But Deus seems to be the fashion nowadays.'

'I'll try to remember; but it still seems silly to me.'

'You'll get used to it: I'll teach you some other reasonably polite expletives, to use when you want to express your feelings...'

'You said that all the old religions have been discredited. So what do people believe nowadays?'

'As little as possible. We're all either Deists or Theists.'

'You've lost me. Definitions, please.'

'They were slightly different in your time, but here are the latest versions. Theists believe there's not more than one God; Deists that there is not less than one God.'

'I'm afraid the distinction's too subtle for me.'

'Not for everyone; you'd be amazed at the bitter controversies it's aroused. Five centuries ago, someone used what's known as surreal mathematics to prove there's an infinite number of grades between Theists and Deists. Of course, like most dabblers with infinity, he went insane. By the way, the best-known Deists were Americans - Washington, Franklin, Jefferson.'

'A little before my time - though you'd be surprised how many people don't realize it.'

'Now I've some good news. Joe - Prof. Anderson - has finally given his - what was the phrase? - OK. You're fit enough to go for a little trip upstairs... to the Lunar Level.'

'Wonderful. How far is that?'

'Oh, about twelve thousand kilometres.'

'Twelve thousand! That will take hours!'

Indra looked surprised at his remark: then she smiled.

'Not as long as you think. No - we don't have a Star Trek Transporter yet - though I believe they're still working on it! But you'll need new clothes, and someone to show you how to wear them. And to help you with the hundreds of little everyday jobs that can waste so much time. So we've taken the liberty of arranging a human personal assistant for you. Come in, Danil.'

Danil was a small, light-brown man in his mid-thirties, who surprised Poole by not giving him the usual palm-top salute, with its automatic exchange of information.

Indeed, it soon appeared that Danil did not possess an Ident: whenever it was needed, he produced a small rectangle of plastic that apparently served the same purpose as the twenty-first century's 'smart cards'.

'Danil will also be your guide and what was that word? - I can never remember - rhymes with "ballet". He's been specially trained for the job. I'm sure you'll find him completely satisfactory.'

Though Poole appreciated this gesture, it made him feel a little uncomfortable. A valet, indeed! He could not recall ever meeting one; in

his time, they were already a rare and endangered species. He began to feel like a character from an early-twentieth-century English novel.

'You have a choice,' said Indra, 'though I know which one you'll take. We can go up on an external elevator, and admire the view - or an interior one, and enjoy a meal and some light entertainment.'

'I can't imagine anyone wanting to stay inside.'

'You'd be surprised. It's too vertiginous for some people - especially visitors from down below. Even mountain climbers who say they've got a head for heights may start to turn green - when the heights are measured in thousands of kilometres, instead of metres.'

'I'll risk it,' Poole answered with a smile. 'I've been higher.'

When they had passed through a double set of airlocks in the exterior wall of the Tower (was it imagination, or did he feel a curious sense of disorientation then?) they entered what might have been the auditorium of a very small theatre. Rows of ten seats were banked up in five tiers: they all faced towards one of the huge picture windows which Poole still found disconcerting, as he could never quite forget the hundreds of tons of air pressure, striving to blast it out into space.

The dozen or so other passengers, who had probably never given the matter any thought, seemed perfectly at ease. They all smiled as they recognized him, nodded politely, then turned away to admire the view.

'Welcome to Skylounge,' said the inevitable autovoice. 'Ascent begins in five minutes. You will find refreshments and toilets on the lower floor.'

Just how long will this trip last? Poole wondered. We're going to travel over twenty thousand clicks, there and back: this will be like no elevator ride I've ever known on Earth...

While he was waiting for the ascent to begin, he enjoyed the stunning panorama laid out two thousand kilometres below. It was winter in the northern hemisphere, but the climate had indeed changed drastically, for there was little snow south of the Arctic Circle.

Europe was almost cloud-free, and there was so much detail that the eye was overwhelmed. One by one he identified the great cities whose names had echoed down the centuries; they had been shrinking even in his time, as the communications revolution changed the face of the world, and had now dwindled still further. There were also some bodies of water in improbable places - the northern Sahara's Lake Saladin was almost a small sea.

Poole was so engrossed by the view that he had forgotten the passage of time. Suddenly he realized that much more than five minutes had passed - yet the elevator was still stationary. Had something gone wrong - or were they waiting for late arrivals?

And then he noticed something so extraordinary that at first he refused to believe the evidence of his eyes. The panorama had expanded, as if he had already risen hundreds of kilometres! Even as he watched, he noticed new features of the planet below creeping into the frame of the window.

Then Poole laughed, as the obvious explanation occurred to him.

'You could have fooled me, Indra! I thought this was real - not a video projection!'

Indra looked back at him with a quizzical smile.

'Think again, Frank. We started to move about ten minutes ago. By now we must be climbing at, oh - at least a thousand kilometres an hour. Though I'm told these elevators can reach a hundred gee at maximum acceleration, we won't touch more than ten, on this short run.'

'That's impossible! Six is the maximum they ever gave me in the centrifuge, and I didn't enjoy weighing half a ton. I know we haven't moved since we stepped inside.'

Poole had raised his voice slightly, and suddenly became aware that the other passengers were pretending not to notice.

'I don't understand how it's done, Frank, but it's called an inertial field. Or sometimes a Sharp one - the "S" stands for a famous Russian scientist, Sakharov - I don't know who the others were.'

Slowly, understanding dawned in Poole's mind - and also a sense of awe-struck wonder. Here indeed was a 'technology indistinguishable from magic'.

'Some of my friends used to dream of "space drives" - energy fields that could replace rockets, and allow movement without any feeling of acceleration. Most of us thought they were crazy - but it seems they were right! I can still hardly believe it... and unless I'm mistaken, we're starting to lose weight.'

'Yes - it's adjusting to the lunar value. When we step out, you'll feel we're on the Moon. But for goodness' sake, Frank - forget you're an engineer, and simply enjoy the view.'

It was good advice, but even as he watched the whole of Africa, Europe and much of Asia flow into his field of vision, Poole could not tear his mind away from this astonishing revelation. Yet he should not have been wholly surprised: he knew that there had been major breakthroughs in space propulsion systems since his time, but had not realized that they would have such dramatic applications to everyday life - if that term could be applied to existence in a thirty-six-thousand-kilometre-high skyscraper.

And the age of the rocket must have been over, centuries ago. All his knowledge of propellant systems and combustion chambers, ion thrusters

and fusion reactors, was totally obsolete. Of course, that no longer mattered - but he understood the sadness that the skipper of a windjammer must have felt, when sail gave way to steam.

His mood changed abruptly, and he could not help smiling, when the robovoice announced, 'Arriving in two minutes. Please make sure that you do not leave any of your personal belongings behind.'

How often he had heard that announcement, on some commercial flight? He looked at his watch, and was surprised to see that they had been ascending for less than half an hour. So that meant an average speed of at least twenty thousand kilometres an hour, yet they might never have moved. What was even stranger - for the last ten minutes or more they must actually have been decelerating so rapidly that by rights they should all have been standing on the roof, heads pointing towards Earth!

The doors opened silently, and as Poole stepped out he again felt the slight disorientation he had noticed on entering the elevator lounge. This time, however, he knew what it meant: he was moving through the transition zone where the inertial field overlapped with gravity - at this level, equal to the Moon's.

Indra and Danil followed him, walking carefully now at a third of their customary weight, as they went forward to meet the next of the day's wonders.

Though the view of the receding Earth had been awesome, even for an astronaut, there was nothing unexpected or surprising about it. But who would have imagined a gigantic chamber, apparently occupying the entire width of the Tower, so that the far wall was more than five kilometres away? Perhaps by this time there were larger enclosed volumes on the Moon and Mars, but this must surely be one of the largest in space itself.

They were standing on a viewing platform, fifty metres up on the outer wall, looking across an astonishingly varied panorama. Obviously, an

attempt had been made to reproduce a whole range of terrestrial biomes. Immediately beneath them was a group of slender trees which Poole could not at first identify: then he realized that they were oaks, adapted to one-sixth of their normal gravity. What, he wondered, would palm trees look like here? Giant reeds, probably...

In the middle-distance there was a small lake, fed by a river that meandered across a grassy plain, then disappeared into something that looked like a single gigantic banyan tree. What was the source of the water? Poole had become aware of a faint drumming sound, and as he swept his gaze along the gently curving wall, he discovered a miniature Niagara, with a perfect rainbow hovering in the spray above it.

He could have stood here for hours, admiring the view and still not exhausting all the wonders of this complex and brilliantly contrived simulation of the planet below. As it spread out into new and hostile environments, perhaps the human race felt an ever-increasing need to remember its origins. Of course, even in his own time every city had its parks as - usually feeble - reminders of Nature. The same impulse must be acting here, on a much grander scale. Central Park, Africa Tower!

'Let's go down,' said Indra. 'There's so much to see, and I don't come here as often as I'd like.'

Followed by the silent but ever-present Danil, who always seemed to know when he was needed but otherwise kept out of the way, they began a leisurely exploration of this oasis in space. Though walking was almost effortless in this low gravity, from time to time they took advantage of a small monorail, and stopped once for refreshments at a cafe', cunningly concealed in the trunk of a redwood that must have been at least a quarter of a kilometre tall.

There were very few other people about - their fellow passengers had long since disappeared into the landscape - so it was as if they had all this wonderland to themselves.

Everything was so beautifully maintained, presumably by armies of robots, that from time to time Poole was reminded of a visit he had made to Disney World as a small boy. But this was even better: there were no crowds, and indeed very little reminder of the human race and its artefacts.

They were admiring a superb collection of orchids, some of enormous size, when Poole had one of the biggest shocks of his life. As they walked past a typical small gardener's shed, the door opened - and the gardener emerged.

Frank Poole had always prided himself on his self-control, and never imagined that as a full-grown adult he would give a cry of pure fright. But like every boy of his generation, he had seen all the 'Jurassic' movies - and he knew a raptor when he met one eye to eye.

'I'm terribly sorry,' said Indra, with obvious concern. 'I never thought of warning you.'

Poole's jangling nerves returned to normal. Of course, there could be no danger, in this perhaps too-well-ordered world: but still...!

The dinosaur returned his stare with apparent total disinterest, then doubled back into the shed and emerged again with a rake and a pair of garden shears, which it dropped into a bag hanging over one shoulder. It walked away from them with a bird-like gait, never looking back as it disappeared behind some ten-metre-high sunflowers.

'I should explain,' said Indra contritely. 'We like to use bio-organisms when we can, rather than robots - I suppose it's carbon chauvinism! Now, there are only a few animals that have any manual dexterity, and we've used them all at one time or another.'

'And here's a mystery that no one's been able to solve. You'd think that enhanced herbivores like orangutans and gorillas would be good at this sort of work. Well, they're not; they don't have the patience for it.'

'Yet carnivores like our friend here are excellent, and easily trained. What's more - here's another paradox! -after they've been modified they're docile and good-natured. Of course, there's almost a thousand years of genetic engineering behind them, and look what primitive man did to the wolf, merely by trial and error!'

Indra laughed and continued: 'You may not believe this, Frank, but they also make good baby-sitters - children love them! There's a five-hundred-year-old joke: "Would you trust your kids to a dinosaur?" "What - and risk injuring it?"'

Poole joined in the laughter, partly in shame-faced reaction to his own fright. To change the subject, he asked Indra the question that was still worrying him.

'All this,' he said, 'it's wonderful - but why go to so much trouble, when anyone in the Tower can reach the real thing, just as quickly?'

Indra looked at him thoughtfully, weighing her words. 'That's not quite true. It's uncomfortable - even dangerous - for anyone who lives above the half-gee level to go down to Earth, even in a hoverchair. So it has to be this -or, as you used to say, Virtual Reality.'

(Now I begin to understand, Poole told himself bleakly. That explains Anderson's evasiveness, and all the tests he's been doing to see if I've regained my strength. I've come all the way back from Jupiter, to within two thousand kilometres of Earth - but I may never again walk on the surface of my home planet. I'm not sure how I will be able to handle this...)

Homage to Icarus

His depression quickly passed: there was so much to do and see. A thousand lifetimes would not have been enough, and the problem was to choose which of the myriad distractions this age could offer. He tried, not always successfully, to avoid the trivia, and to concentrate on the things that mattered - notably his education.

The Braincap - and the book-sized player that went with it, inevitably called the Brainbox - was of enormous value here. He soon had a small library of 'instant knowledge' tablets, each containing all the material needed for a college degree. When he slipped one of these into the Brainbox, and gave it the speed and intensity adjustments that most suited him, there would be a flash of light, followed by a period of unconsciousness that might last as long as an hour. When he awoke, it seemed that new areas of his mind had been opened up, though he only knew they were there when he searched for them. It was almost as if he was the owner of a library who had suddenly discovered shelves of books he did not know he possessed.

To a large extent, he was the master of his own time. Out of a sense of duty - and gratitude - he acceded to as many requests as he could from scientists, historians, writers and artists working in media that were often incomprehensible to him. He also had countless invitations from other citizens of the four Towers, virtually all of which he was compelled to turn down.

Most tempting - and most hard to resist - were those that came from the beautiful planet spread out below. 'Of course,' Professor Anderson had told him, 'you'd survive if you went down for short time with the right life-support system, but you wouldn't enjoy it. And it might weaken your

neuromuscular system even further. It's never really recovered from that thousand-year sleep.'

His other guardian, Indra Wallace, protected him from unnecessary intrusions, and advised him which requests he should accept - and which he should politely refuse. By himself, he would never understand the socio-political structure of this incredibly complex culture, but he soon gathered that, although in theory all class distinctions had vanished, there were a few thousand super-citizens. George Orwell had been right; some would always be more equal than others.

There had been times when, conditioned by his twentyfirst-century experience, Poole had wondered who was paying for all this hospitality - would he one day be presented with the equivalent of an enormous hotel bill? But Indra had quickly reassured him: he was a unique and priceless museum exhibit, so would never have to worry about such mundane considerations. Anything he wanted - within reason - would be made available to him: Poole wondered what the limits were, never imagining that one day he would attempt to discover them.

All the most important things in life happen by accident, and he had set his wall display browser on random scan, silent, when a striking image caught his attention.

'Stop scan! Sound up!' he shouted, with quite unnecessary loudness.

He recognized the music, but it was a few minutes before he identified it; the fact that his wall was filled with winged humans circling gracefully round each other undoubtedly helped. But Tchaikovsky would have been utterly astonished to see this performance of Swan Lake - with the dancers actually flying...

Poole watched, entranced, for several minutes, until he was fairly confident that this was reality, and not a simulation: even in his own day, one could never be quite certain. Presumably the ballet was being performed in one of the many low-gravity environments - a very large one, judging by some of the images. It might even be here in Africa Tower.

I want to try that, Poole decided. He had never quite forgiven the Space Agency for banning one of his greatest pleasures - delayed parachute formation jumping - even though he could see the Agency's point in not wanting to risk a valuable investment. The doctors had been quite unhappy about his earlier hang-gliding accident; fortunately his teenage bones had healed completely.

'Well,' he thought, 'there's no one to stop me now unless it's Prof. Anderson...'

To Poole's relief, the physician thought it an excellent idea, and he was also pleased to find that every one of the Towers had its own Aviary, up at the one-tenth-gee level.

Within a few days he was being measured for his wings, not in the least like the elegant versions worn by the performers of Swan Lake. Instead of feathers there was a flexible membrane, and when he grasped the hand-holds attached to the supporting ribs, Poole realized that he must look much more like a bat than a bird. However his 'Move over, Dracula!' was completely wasted on his instructor, who was apparently unacquainted with vampires.

For his first lessons he was restrained by a light harness, so that he did not move anywhere while he was taught the basic strokes - and, most important of all, learned control and stability. Like many acquired skills, it was not quite as easy as it looked.

He felt ridiculous in this safety-harness - how could anyone injure themselves at a tenth of a gravity! - and was glad that he needed only a few lessons; doubtless his astronaut training helped. He was, the Wingmaster told him, the best pupil he had ever taught: but perhaps he said that to all of them.

After a dozen free-flights in a chamber forty metres on a side, criss-crossed with various obstacles which he easily avoided, Poole was given the all-clear for his first solo - and felt nineteen years old again, about to take off in the Flagstaff Aero Club's antique Cessna.

The unexciting name 'The Aviary' had not prepared him for the venue of this maiden flight. Though it seemed even more enormous than the space holding the forests and gardens down at the lunar-gee level, it was almost the same size, since it too occupied an entire floor of the gently tapering Tower. A circular void, half a kilometre high and over four kilometres wide, it appeared truly enormous, as there were no features on which the eye could rest. Because the walls were a uniform pale blue, they contributed to the impression of infinite space.

Poole had not really believed the Wingmaster's boast, 'You can have any scenery you like', and intended to throw him what he was sure was an impossible challenge. But on this first flight, at the dizzy altitude of fifty metres, there were no visual distractions. Of course, a fall from the equivalent altitude of five metres in the ten-fold greater Earth gravity could break one's neck; however, even minor bruises were unlikely here, as the entire floor was covered with a network of flexible cables. The whole chamber was a giant trampoline; one could, thought Poole, have a lot of fun here - even without wings.

With firm, downward strokes, Poole lifted himself into the air. In almost no time, it seemed that he was a hundred metres in the air, and still rising.

'Slow down' said the Wingmaster, 'I can't keep up with you,'

Poole straightened out, then attempted a slow roll. He felt light-headed as well as light-bodied (less than ten kilograms!) and wondered if the concentration of oxygen had been increased.

This was wonderful - quite different from zero gravity, as it posed more of a physical challenge. The nearest thing to it was scuba diving: he wished there were birds here, to emulate the equally colourful coral fish who had so often accompanied him over tropical reefs.

One by one, the Wingmaster put him through a series of manoeuvres - rolls, loops, upside-down flying, hovering.

Finally he said: 'Nothing more I can teach you. Now let's enjoy the view.'

Just for a moment, Poole almost lost control - as he was probably expected to do. For, without the slightest warning, he was surrounded by snow-capped mountains, and was flying down a narrow pass, only metres from some unpleasantly jagged rocks.

Of course, this could not be real: those mountains were as insubstantial as clouds, and he could fly right through them if he wished. Nevertheless, he veered away from the cliff-face (there was an eagle's nest on one of its ledges, holding two eggs which he felt he could touch if he came closer) and headed for more open space.

The mountains vanished; suddenly, it was night. And then the stars came out - not the miserable few thousand in the impoverished skies of Earth, but legions beyond counting. And not only stars, but the spiral whirlpools of distant galaxies, the teeming, close-packed sun-swarms of globular clusters.

There was no possible way this could be real, even if he had been magically transported to some world where such skies existed. For those galaxies were receding even as he watched; stars were fading, exploding,

being born in stellar nurseries of glowing fire-mist. Every second, a million years must be passing...

The overwhelming spectacle disappeared as quickly as it had come: he was back in the empty sky, alone except for his instructor, in the featureless blue cylinder of the Aviary.

'I think that's enough for one day,' said the Wingmaster, hovering a few metres above Poole. 'What scenery would you like, the next time you come here?'

Poole did not hesitate. With a smile, he answered the question.

11

Here be Dragons

He would never have believed it possible, even with the technology of this day and age. How many terabytes - petabytes - was there a large enough word? - of information must have been accumulated over the centuries, and in what sort of storage medium? Better not think about it, and follow Indra's advice: 'Forget you're an engineer - and enjoy yourself.'

He was certainly enjoying himself now, though his pleasure was mixed with an almost overwhelming sense of nostalgia. For he was flying, or so it seemed, at an altitude of about two kilometres, above the spectacular and unforgotten landscape of his youth. Of course, the perspective was false, since the Aviary was only half a kilometre high, but the illusion was perfect.

He circled Meteor Crater, remembering how he had scrambled up its sides during his earlier astronaut training. How incredible that anyone

could ever have doubted its origin, and the accuracy of its name! Yet well into the twentieth century, distinguished geologists had argued that it was volcanic: not until the coming of the Space Age was it - reluctantly - accepted that all planets were still under continual bombardment.

Poole was quite sure that his comfortable cruising speed was nearer twenty than two hundred kilometres an hour, yet he had been allowed to reach Flagstaff in less than fifteen minutes. And there were the whitely-gleaming domes of the Lowell Observatory, which he had visited so often as a boy, and whose friendly staff had undoubtedly been responsible for his choice of career. He had sometimes wondered what his profession might have been, had he not been born in Arizona, near the very spot where the most long-enduring and influential of Martian fantasies had been created. Perhaps it was imagination, but Poole thought he could just see Lowell's unique tomb, close to the great telescope, which had fuelled his dreams.

From what year, and what season, had this image been captured? He guessed it had come from the spy satellites which had watched over the world of the early twenty-first century. It could not be much later than his own time, for the layout of the city was just as he remembered. Perhaps if he went low enough he would even see himself...

But he knew that was absurd; he had already discovered that this was the nearest he could get. If he flew any closer, the image would start to breakup, revealing its basic pixels. It was better to keep his distance, and not destroy the beautiful illusion.

And there - it was incredible! - was the little park where he had played with his junior and high-school friends. The City Fathers were always arguing about its maintenance, as the water supply became more and more critical. Well, at least it had survived to this time - whenever that might be.

And then another memory brought tears to his eyes. Along those narrow paths, whenever he could get home from Houston or the Moon, he had

walked with his beloved Rhodesian Ridgeback, throwing sticks for him to retrieve, as man and dog had done from time immemorial.

Poole had hoped, with all his heart, that Rikki would still be there to greet him when he returned from Jupiter, and had left him in the care of his younger brother Martin. He almost lost control, and sank several metres before regaining stability, as he once more faced the bitter truth that both Rikki and Martin had been dust for centuries.

When he could see properly again, he noticed that the dark band of the Grand Canyon was just visible on the far horizon. He was debating whether to head for it - he was growing a little tired - when he became aware that he was not alone in the sky. Something else was approaching, and it was certainly not a human flyer. Although it was difficult to judge distances here, it seemed much too large for that.

Well, he thought, I'm not particularly surprised to meet a pterodactyl here - indeed, it's just the sort of thing I'd expect. I hope it's friendly - or that I can outfly it if it isn't. Oh, no!

A pterodactyl was not a bad guess: maybe eight points out of ten. What was approaching him now, with slow flaps of its great leathery wings, was a dragon straight out of Fairyland. And, to complete the picture, there was a beautiful lady riding on its back. At least, Poole assumed she was beautiful. The traditional image was rather spoiled by one trifling detail: much of her face was concealed by a large pair of aviator's goggles that might have come straight from the open cockpit of a World War I biplane.

Poole hovered in mid-air, like a swimmer treading water, until the oncoming monster came close enough for him to hear the flapping of its great wings. Even when it was less than twenty metres away, he could not decide whether it was a machine or a bio-construct: probably both.

And then he forgot about the dragon, for the rider removed her goggles.

The trouble with cliché's, some philosopher remarked, probably with a yawn, is that they are so boringly true.

But 'love at first sight' is never boring.

Danil could provide no information, but then Poole had not expected any from him. His ubiquitous escort - he certainly would not pass muster as a classic valet - seemed so limited in his functions that Poole sometimes wondered if he was mentally handicapped, unlikely though that seemed. He understood the functioning of all the household appliances, carried out simple orders with speed and efficiency, and knew his way about the Tower. But that was all; it was impossible to have an intelligent conversation with him, and any polite queries about his family were met with a look of blank incomprehension. Poole had even wondered if he too was a bio-robot.

Indra, however, gave him the answer he needed right away.

'Oh, you've met the Dragon Lady!'

'Is that what you call her? What's her real name - and can you get me her Ident? We were hardly in a position to touch palms.'

'Of course - no problemo.'

'Where did you pick up that?'

Indra looked uncharacteristically confused.

'I've no idea - some old book or movie. Is it a good figure of speech?'

'Not if you're over fifteen.'

'I'll try to remember. Now tell me what happened - unless you want to make me jealous.'

They were now such good friends that they could discuss any subject with perfect frankness. Indeed, they had laughingly lamented their total lack of romantic interest in each other - though Indra had once commented, 'I guess that if we were both marooned on a desert asteroid, with no hope of rescue, we could come to some arrangement.'

'First, you tell me who she is.'

'Her name's Aurora McAuley; among many other things, she's President of the Society for Creative Anachronisms. And if you thought Draco was impressive, wait until you see some of their other - ah - creations. Like Moby Dick - and a whole zooful of dinosaurs Mother Nature never thought of.'

This is too good to be true, thought Poole.

I am the biggest anachronism on Planet Earth.

12

Frustration

Until now, he had almost forgotten that conversation with the Space Agency psychologist.

'You may be gone from Earth for at least three years. If you like, I can give you a harmless anaphrodisiac implant that will last out the mission. I promise we'll more than make it up, when you get home.'

'No thanks,' Poole had answered, trying to keep his face straight when he continued, 'I think I can handle it.'

Nevertheless, he had become suspicious after the third or fourth week - and so had Dave Bowman.

'I've noticed it too,' Dave said 'I bet those damn doctors put something in our diet...'

Whatever that something was - if indeed it had ever existed - it was certainly long past its shelf-life. Until now, Poole had been too busy to get involved in any emotional entanglements, and had politely turned down generous offers from several young (and not so young) ladies. He was not sure whether it was his physique or his fame that appealed to them: perhaps it was nothing more than simple curiosity about a man who, for all they knew, might be an ancestor from twenty or thirty generations in the past.

To Poole's delight, Mistress McAuley's Ident conveyed the information that she was currently between lovers, and he wasted no further time in contacting her. Within twenty-four hours he was pillion-riding, with his arms enjoyably around her waist. He had also learned why aviator's goggles were a good idea, for Draco was entirely robotic, and could easily cruise at a hundred clicks. Poole doubted if any real dragons had ever attained such speeds.

He was not surprised that the ever-changing landscapes below them were straight out of legend. Ali Baba had waved angrily at them, as they overtook his flying carpet, shouting 'Can't you see where you're going!' Yet he must be a long way from Baghdad, because the dreaming spires over which they now circled could only be Oxford.

Aurora confirmed his guess as she pointed down: 'That's the pub - the inn - where Lewis and Tolkien used to meet their friends, the Inklings.'

And look at the river - that boat just coming out from the bridge - do you see the two little girls and the clergyman in it?'

'Yes,' he shouted back against the gentle sussuration of Draco's slipstream. 'And I suppose one of them is Alice.'

Aurora turned and smiled at him over her shoulder: she seemed genuinely delighted.

'Quite correct: she's an accurate replica, based on the Reverend's photos. I was afraid you wouldn't know. So many people stopped reading soon after your time.'

Poole felt a glow of satisfaction.

I believe I've passed another test, he told himself smugly. Riding on Draco must have been the first. How many more, I wonder? Fighting with broadswords?

But there were no more, and the answer to the immemorial 'Your place or mine?' was - Poole's.

The next morning, shaken and mortified, he contacted Professor Anderson.

'Everything was going splendidly,' he lamented, 'when she suddenly became hysterical and pushed me away. I was afraid I'd hurt her somehow -'Then she called the roomlight - we'd been in darkness - and jumped out of bed. I guess I was just staring like a fool...' He laughed ruefully. 'She was certainly worth staring at.'

'I'm sure of it. Go on.'

'After a few minutes she relaxed and said something I'll never be able to forget.'

Anderson waited patiently for Poole to compose himself. 'She said: "I'm really sorry, Frank. We could have had a good time. But I didn't know that you'd been - mutilated."

The professor looked baffled, but only for a moment. 'Oh - I understand. I'm sorry too, Frank - perhaps I should have warned you. In my thirty years of practice, I've only seen half a dozen cases - all for valid medical reasons, which certainly didn't apply to you...'

'Circumcision made a lot of sense in primitive times - and even in your century - as a defence against some unpleasant - even fatal - diseases in backward countries with poor hygiene. But otherwise there was absolutely no excuse for it - and several arguments against, as you've just discovered!'

'I checked the records after I'd examined you the first time, and found that by mid-twenty-first century there had been so many malpractice suits that the American Medical Association had been forced to ban it. The arguments among the contemporary doctors are very entertaining.'

'I'm sure they are,' said Poole morosely.

'In some countries it continued for another century: then some unknown genius coined a slogan - please excuse the vulgarity - "God designed us: circumcision is blasphemy". That more or less ended the practice. But if you want, it would be easy to arrange a transplant - you wouldn't be making medical history, by any means.'

'I don't think it would work. Afraid I'd start laughing every time.'

'That's the spirit - you're already getting over it.'

Somewhat to his surprise, Poole realized that Anderson's prognosis was correct. He even found himself already laughing.

'Now what, Frank?'

'Aurora's "Society for Creative Anachronisms". I'd hoped it would improve my chances. Just my luck to have found one anachronism she doesn't appreciate.'

13

Stranger in a Strange Time

Indra was not quite as sympathetic as he had hoped: perhaps, after all, there was some sexual jealousy in their relationship. And - much more serious - what they wryly labelled the Dragon Debacle led to their first real argument.

It began innocently enough, when Indra complained:

'People are always asking me why I've devoted my life to such a horrible period of history, and it's not much of an answer to say that there were even worse ones.'

'Then why are you interested in my century?'

'Because it marks the transition between barbarism and civilization.'

'Thank you. Just call me Conan.'

'Conan? The only one I know is the man who invented Sherlock Holmes.'

'Never mind - sorry I interrupted. Of course, we in the so-called developed countries thought we were civilized. At least war wasn't respectable any more, and the United Nations was always doing its best to stop the wars that did break out.'

'Not very successfully: I'd give it about three out of ten. But what we find incredible is the way that people - right up to the early 2000s! - calmly accepted behaviour we would consider atrocious. And believed in the most mind-boggled -'

'Boggling.'

'- nonsense, which surely any rational person would dismiss out of hand.'

'Examples, please.'

'Well, your really trivial loss started me doing some research, and I was appalled by what I found. Did you know that every year in some countries thousands of little girls were hideously mutilated to preserve their virginity? Many of them died - but the authorities turned a blind eye.'

'I agree that was terrible - but what could my government do about it?'

'A great deal - if it wished. But that would have offended the people who supplied it with oil and bought its weapons, like the landmines that killed and maimed civilians by the thousand.'

'You don't understand, Indra. Often we had no choice: we couldn't reform the whole world. And didn't somebody once say "Politics is the art of the possible"?''

'Quite true - which is why only second-rate minds go into it. Genius likes to challenge the impossible.'

'Well, I'm glad you have a good supply of genius, so you can put things right.'

'Do I detect a hint of sarcasm? Thanks to our computers, we can run political experiments in cyberspace before trying them out in practice. Lenin was unlucky; he was born a hundred years too soon. Russian communism might have worked - at least for a while - if it had had microchips. And had managed to avoid Stalin.'

Poole was constantly amazed by Indra's knowledge of his age - as well as by her ignorance of so much that he took for granted. In a way, he had the reverse problem. Even if he lived the hundred years that had been confidently promised him, he could never learn enough to feel at home. In any conversation, there would always be references he did not understand, and jokes that would go over his head. Worse still, he would always feel on the verge of some "faux pas" - about to create some social disaster that would embarrass even the best of his new friends...

Such as the occasion when he was lunching, fortunately in his own quarters, with Indra and Professor Anderson. The meals that emerged from the autochef were always perfectly acceptable, having been designed to match his physiological requirements. But they were certainly nothing to get excited about, and would have been the despair of a twenty-first-century gourmet.

Then, one day, an unusually tasty dish appeared, which brought back vivid memories of the deer-hunts and barbecues of his youth. However, there was something unfamiliar about both flavour and texture, so Poole asked the obvious question.

Anderson merely smiled, but for a few seconds Indra looked as if she was about to be sick. Then she recovered and said: 'You tell him - after we've finished eating.'

Now what have I done wrong? Poole asked himself. Half an hour later, with Indra rather pointedly absorbed in a video display at the other end of the room, his knowledge of the Third Millennium made another major advance.

'Corpse-food was on the way out even in your time,' Anderson explained. 'Raising animals to - ugh - eat them became economically impossible. I don't know how many acres of land it took to feed one cow, but at least ten humans could survive on the plants it produced. And probably a hundred, with hydroponic techniques.'

'But what finished the whole horrible business was not economics - but disease. It started first with cattle, then spread to other food animals - a kind of virus, I believe, that affected the brain, and caused a particularly nasty death. Although a cure was eventually found, it was too late to turn back the clock - and anyway, synthetic foods were now far cheaper, and you could get them in any flavour you liked.'

Remembering weeks of satisfying but unexciting meals, Poole had strong reservations about this. For why, he wondered, did he still have wistful dreams of spare-ribs and cordon bleu steaks?

Other dreams were far more disturbing, and he was afraid that before long he would have to ask Anderson for medical assistance. Despite everything that was being done to make him feel at home, the strangeness and sheer complexity of this new world were beginning to overwhelm him. During sleep, as if in an unconscious effort to escape, he often reverted to his earlier life: but when he awoke, that only made matters worse.

He had travelled across to America Tower and looked down, in reality and not in simulation, on the landscape of his youth - and it had not been a good idea. With optical aid, when the atmosphere was clear, he'd got so close that he could see individual human beings as they went about their affairs, sometimes along streets that he remembered...

And always, at the back of his mind, was the knowledge that down there had once lived everyone he had ever loved, Mother, Father (before he had gone off with that Other Woman), dear Uncle George and Aunt Lil, brother Martin - and, not least, a succession of dogs, beginning with the warm puppies of his earliest childhood and culminating in Rikki.

Above all, there was the memory - and mystery - of Helena...

It had begun as a casual affair, in the early days of his astrotraining, but had become more and more serious as the years went by. Just before he had left for Jupiter, they had planned to make it permanent when he returned.

And if he did not, Helena wished to have his child. He still recalled the blend of solemnity and hilarity with which they had made the necessary arrangements...

Now, a thousand years later, despite all his efforts, he had been unable to find if Helena had kept her promise. Just as there were now gaps in his own memory, so there were also in the collective records of Mankind. The worst was that created by the devastating electromagnetic pulse from the 2304 asteroid impact, which had wiped out several per cent of the world's information banks, despite all backups and safety systems. Poole could not help wondering if, among all the exabytes that were irretrievably lost, were the records of his own children: even now, his descendants of the thirtieth generation might be walking the Earth; but he would never know.

It helped a little to have discovered that - unlike Aurora - some ladies of this era did not consider him to be damaged goods. On the contrary: they often found his alteration quite exciting, but this slightly bizarre reaction made it impossible for Poole to establish any close relationship. Nor was he anxious to do so; all that he really needed was the occasional healthy, mindless exercise.

Mindless - that was the trouble. He no longer had arty purpose in life. And the weight of too many memories was upon him; echoing the title of a famous book he had read in his youth, he often said to himself, 'I am a Stranger in a Strange Time.'

There were even occasions when he looked down at the beautiful planet on which - if he obeyed doctor's orders - he could never walk again, and wondered what it would be like to make a second acquaintance with the vacuum of space. Though it was not easy to get through the airlocks without triggering some alarm, it had been done: every few years, some determined suicide made a brief meteoric display in the Earth's atmosphere.

Perhaps it was just as well that deliverance was on its way, from a completely unexpected direction.

* * *

'Nice to meet you, Commander Poole - for the second time.'

'I'm sorry - don't recall - but then I see so many people.'

'No need to apologize. First time was out round Neptune.'

'Captain Chandler - delighted to see you! Can I get something from the autochef?'

'Anything with over twenty per cent alcohol will be fine.'

'And what are you doing back on Earth? They told me you never come inside Mars orbit.'

'Almost true - though I was born here, I think it's a dirty, smelly place - too many people - creeping up to a billion again!'

'More than ten billion in my time. By the way, did you get my "Thank you" message?'

'Yes - and I know I should have contacted you. But I waited until I headed sunwards again. So here I am. Your good health!'

As the Captain disposed of his drink with impressive speed, Poole tried to analyse his visitor. Beards - even small goatees like Chandler's - were very rare in this society, and he had never known an astronaut who wore one: they did not co-exist comfortably with space-helmets. Of course, a Captain might go for years between EVs, and in any case most outside jobs were done by robots; but there was always the risk of the unexpected, when one might have to get suited in a hurry. It was obvious that Chandler was something of an eccentric, and Poole's heart warmed to him.

'You've not answered my question. If you don't like Earth, what are you doing here?'

'Oh, mostly contacting old friends - it's wonderful to forget hour-long delays, and to have real-time conversations! But of course that's not the reason. My old rust-bucket is having a refit, up at the Rim shipyard. And the armour has to be replaced; when it gets down to a few centimetres thick, I don't sleep too well.'

'Armour?'

'Dust shield. Not such a problem in your time, was it? But it's a dirty environment out round Jupiter, and our normal cruise speed is several thousand clicks - a second! So there's a continuous gentle pattering, like raindrops on the roof.'

'You're joking!'

'Course I am. If we really could hear anything, we'd be dead. Luckily, this sort of unpleasantness is very rare - last serious accident was twenty years ago. We know all the main comet streams, where most of the junk is, and are careful to avoid them - except when we're matching velocity to round up ice.

'But why don't you come aboard and have a look around, before we take off for Jupiter?'

'I'd be delighted... did you say Jupiter?'

'Well, Ganymede, of course - Anubis City. We've a lot of business there, and several of us have families we haven't seen for months.'

Poole scarcely heard him.

Suddenly - unexpectedly - and perhaps none too soon, he had found a reason for living.

Commander Frank Poole was the sort of man who hated to leave a job undone - and a few specks of cosmic dust, even moving at a thousand kilometres a second, were not likely to discourage him.

He had unfinished business at the world once known as Jupiter.



GOLIATH

'Anything you want within reason,' he had been told. Frank Poole was not sure if his hosts would consider that returning to Jupiter was a reasonable request; indeed, he was not quite sure himself, and was beginning to have second thoughts.

He had already committed himself to scores of engagements, weeks in advance. Most of them he would be happy to miss, but there were some he would be sorry to forgo. In particular, he hated to disappoint the senior class from his old high school - how astonishing that it still existed! - when they planned to visit him next month.

However, he was relieved - and a little surprised - when both Indra and Professor Anderson agreed that it was an excellent idea. For the first time, he realized that they had been concerned with his mental health; perhaps a holiday from Earth would be the best possible cure.

And, most important of all, Captain Chandler was delighted. 'You can have my cabin,' he promised. 'I'll kick the First Mate out of hers.' There were times when Poole wondered if Chandler, with his beard and swagger, was not another anachronism. He could easily picture him on the bridge of a battered three-master, with Skull and Crossbones flying overhead.

Once his decision had been made, events moved with surprising speed. He had accumulated very few possessions, and fewer still that he needed to take with him. The most important was Miss Pringle, his electronic alter ego and secretary, now the storehouse of both his lives, and the small stack of terabyte memories that went with her.

Miss Pringle was not much larger than the hand-held personal assistants of his own age, and usually lived, like the Old West's Colt 45, in a quick-draw holster at his waist. She could communicate with him by audio or Braincap, and her prime duty was to act as an information filter and a buffer to the outside world. Like any good secretary, she knew when to reply, in the appropriate format: 'I'll put you through now' or - much more frequently: 'I'm sorry - Mr Poole is engaged. Please record your message and he will get back to you as soon as possible.' Usually, this was never.

There were very few farewells to be made: though realtime conversations would be impossible owing to the sluggish velocity of radio waves, he would be in constant touch with Indra and Joseph - the only genuine friends he had made.

Somewhat to his surprise, Poole realized that he would miss his enigmatic but useful 'valet', because he would now have to handle all the small chores of everyday life by himself. Danil bowed slightly when they parted, but otherwise showed no sign of emotion, as they took the long ride up to the outer curve of the world-circling wheel, thirty-six thousand kilometres above central Africa.

'I'm not sure, Dim, that you'll appreciate the comparison. But do you know what Goliath reminds me of?'

They were now such good friends that Poole could use the Captain's nickname - but only when no one else was around.

'Something unflattering, I assume.'

'Not really. But when I was a boy, I came across a whole pile of old science-fiction magazines that my Uncle George had abandoned - "pulp", they were called, after the cheap paper they were printed on... most of

them were already falling to bits. They had wonderful garish covers, showing strange planets and monsters - and, of course, spaceships!

'As I grew older, I realized how ridiculous those spaceships were. They were usually rocket-driven - but there was never any sign of propellant tanks! Some of them had rows of windows from stem to stem, just like ocean liners. There was one favourite of mine with a huge glass dome - a space-going conservatory...

'Well, those old artists had the last laugh: too bad they could never know. Goliath looks more like their dreams than the flying fuel-tanks we used to launch from the Cape.

Your Inertial Drive still seems too good to be true - no visible means of support, unlimited range and speed - sometimes I think I'm the one who's dreaming!'

Chandler laughed and pointed to the view outside.

'Does that look like a dream?'

It was the first time that Poole had seen a genuine horizon since he had come to Star City, and it was not quite as far away as he had expected. After all, he was on the outer rim of a wheel seven times the diameter of Earth, so surely the view across the roof of this artificial world should extend for several hundred kilometres...

He used to be good at mental arithmetic - a rare achievement even in his time, and probably much rarer now. The formula to give the horizon distance was a simple one: the square root of twice your height times the radius - the sort of thing you never forgot, even if you wanted to...

Let's see - we're about 8 metres up - so root 16 - this is easy! - say big R is 40,000 - knock off those three zeros to make it all clicks - 4 times root 40 - hmm - just over 25...

Well, twenty-five kilometres was a fair distance, and certainly no spaceport on Earth had ever seemed this huge. Even knowing perfectly well what to expect, it was uncanny to watch vessels many times the size of his long-lost Discovery lifting off, not only with no sound, but with no apparent means of propulsion. Though Poole missed the flame and fury of the old-time countdowns, he had to admit that this was cleaner, more efficient - and far safer.

Strangest of all, though, was to sit up here on the Rim, in the Geostationary Orbit itself - and to feel weight! Just metres away, outside the window of the tiny observation lounge, servicing robots and a few spacesuited humans were gliding gently about their business; yet here inside Goliath the inertial field was maintaining standard Mars-gee.

'Sure you don't want to change your mind, Frank?' Captain Chandler had asked jokingly, as he left for the bridge. 'Still ten minutes before lift-off.'

'Wouldn't be very popular if I did, would I? No - as they used to say back in the old days - we have commit. Ready or not, here I come.'

Poole felt the need to be alone when the drive went on, and the tiny crew - only four men and three women - respected his wish. Perhaps they guessed how he must be feeling, to leave Earth for the second time in a thousand years - and, once again, to face an unknown destiny.

Jupiter-Lucifer was on the other side of the Sun, and the almost straight line of Goliath's orbit would take them close to Venus. Poole looked forward to seeing, with his own unaided eyes, if Earth's sister planet was now beginning to live up to that description, after centuries of terraforming.

From a thousand kilometres up, Star City looked like a gigantic metal band around Earth's Equator, dotted with gantries, pressure domes,

scaffolding holding half-completed ships, antennas, and other more enigmatic structures. It was diminishing swiftly as Goliath headed sunwards, and presently Poole could see how incomplete it was: there were huge gaps spanned only by a spider's web of scaffolding, which would probably never be completely enclosed.

And now they were falling below the plane of the ring; it was midwinter in the northern hemisphere, so the slim halo of Star City was inclined at over twenty degrees to the Sun. Already Poole could see the American and Asian towers, as shining threads stretching outwards and away, beyond the blue haze of the atmosphere.

He was barely conscious of time as Goliath gained speed, moving more swiftly than any comet that had ever fallen sunwards from interstellar space. The Earth, almost full, still spanned his field of view, and he could now see the full length of the Africa Tower which had been his home in the life he was now leaving - perhaps, he could not help thinking, leaving for ever.

When they were fifty thousand kilometres out, he was able to view the whole of Star City, as a narrow ellipse enclosing the Earth. Though the far side was barely visible, as a hair-line of light against the stars, it was awe-inspiring to think that the human race had now set this sign upon the heavens.

Then Poole remembered the rings of Saturn, infinitely more glorious. The astronomical engineers still had a long, long way to go, before they could match the achievements of Nature.

Or, if that was the right word, Deus.

Transit of Venus

When he woke the next morning, they were already at Venus. But the huge, dazzling crescent of the still cloud-wrapped planet was not the most striking object in the sky:

Goliath was floating above an endless expanse of crinkled silver foil, flashing in the sunlight with ever-changing patterns as the ship drifted across it.

Poole remembered that in his own age there had been an artist who had wrapped whole buildings in plastic sheets: how he would have loved this opportunity to package billions of tons of ice in a glittering envelope... Only in this way could the core of a comet be protected from evaporation on its decades-long journey sunwards.

'You're in luck, Frank,' Chandler had told him. 'This is something I've never seen myself. It should be spectacular. Impact due in just over an hour. We've given it a little nudge, to make sure it comes down in the right place. Don't want anyone to get hurt.'

Poole looked at him in astonishment.

'You mean - there are already people on Venus?'

'About fifty mad scientists, near the South Pole. Of course, they're well dug in, but we should shake them up a bit - even though Ground Zero is on the other side of the planet. Or I should say "Atmosphere Zero" - it will be days before anything except the shockwave gets down to the surface.'

As the cosmic iceberg, sparkling and flashing in its protective envelope, dwindled away towards Venus, Poole was struck with a sudden, poignant memory. The Christmas trees of his childhood had been adorned with just such ornaments, delicate bubbles of coloured glass. And the comparison was not completely ludicrous: for many families on Earth, this was still the right season for gifts, and Goliath was bringing a present beyond price to another world.

The radar image of the tortured Venusian landscape - its weird volcanoes, pancake domes, and narrow, sinuous canyons - dominated the main screen of Goliath's control centre, but Poole preferred the evidence of his own eyes. Although the unbroken sea of clouds that covered the planet revealed nothing of the inferno beneath, he wanted to see what would happen when the stolen comet struck. In a matter of seconds, the myriad of tons of frozen hydrates that had been gathering speed for decades on the downhill run from Neptune would deliver all their energy...

The initial flash was even brighter than he had expected. How strange that a missile made of ice could generate temperatures that must be in the tens of thousands of degrees! Though the filters of the view-port would have absorbed all the dangerous shorter wave-lengths, the fierce blue of the fireball proclaimed that it was hotter than the Sun.

It was cooling rapidly as it expanded - through yellow, orange, red... The shockwave would now be spreading outwards at the velocity of sound - and what a sound that must be! - so in a few minutes there should be some visible indication of its passage across the face of Venus.

And there it was! Only a tiny black ring - like an insignificant puff of smoke, giving no hint of the cyclonic fury that must be blasting its way outwards from the point of impact. As Poole watched, it slowly expanded, though owing to its scale there was no sense of visible movement: he had to wait for a full minute before he could be quite sure that it had grown larger.

After a quarter of an hour, however, it was the most prominent marking on the planet. Though much fainter - a dirty grey, rather than black - the shockwave was now a ragged circle more than a thousand kilometres across. Poole guessed that it had lost its original symmetry while sweeping over the great mountain ranges that lay beneath it.

Captain Chandler's voice sounded briskly over the ship's address system.

'Putting you through to Aphrodite Base. Glad to say they're not shouting for help -'

'- shook us up a bit, but just what we expected. Monitors indicate some rain already over the Nokomis Mountains - it will soon evaporate, but that's a beginning. And there seems to have been a flash-flood in Hecate Chasm - too good to be true, but we're checking. There was a temporary lake of boiling water there after the last delivery -'

I don't envy them, Poole told himself - but I certainly admire them. They prove that the spirit of adventure still exists in this perhaps too-comfortable and too-well-adjusted society.

'- and thanks again for bringing this little load down in the right place. With any luck - and if we can get that sun-screen up into sync orbit - we'll have some permanent seas before long. And then we can plant coral reefs, to make lime and pull the excess CO₂ out of the atmosphere - hope I live to see it!'

I hope you do, thought Poole in silent admiration. He had often dived in the tropical seas of Earth, admiring weird and colourful creatures so bizarre that it was hard to believe anything stranger would be found, even on the planets of other suns.

'Package delivered on time, and receipt acknowledged,' said Captain Chandler with obvious satisfaction. 'Goodbye Venus - Ganymede, here we come.'

MISS PRINGLE

FILE WALLACE

Hello, Indra. Yes, you were quite right. I do miss our little arguments. Chandler and I get along fine, and at first the crew treated me - this will amuse you - rather like a holy relic. But they're beginning to accept me, and have even started to pull my leg (do you know that idiom?).

It's annoying not to be able to have a real conversation - we've crossed the orbit of Mars, so radio round-trip is already over an hour. But there's one advantage - you won't be able to interrupt me...

Even though it will take us only a week to reach Jupiter, I thought I'd have time to relax. Not a bit of it: my fingers started to itch, and I couldn't resist going back to school. So I've begun basic training, all over again, in one of Goliath's minishuttles. Maybe Dim will actually let me solo...

It's not much bigger than Discovery's pods - but what a difference! First of all, of course, it doesn't use rockets: I can't get used to the luxury of the inertial drive, and unlimited range. Could fly back to Earth if I had to - though I'd probably get - remember the phrase I used once, and you guessed its meaning? - 'stir crazy'.

The biggest difference, though, is the control system. It's been a big challenge for me to get used to hands-off operation - and the computer has had to learn to recognize my voice commands. At first it was asking every five minutes 'Do you really mean that?' I know it would be better to use

the Braincap - but I'm still not completely confident with that gadget. Not sure if I'll ever get used to something reading my mind.

By the way, the shuttle's called Falcon. It's a nice name - and I was disappointed to find that no one aboard knew that it goes all the way back to the Apollo missions, when we first landed on the Moon...

Uh-huh - there was a lot more I wanted to say, but the skipper is calling. Back to the classroom - love and out.

STORE

TRANSMIT

Hello Frank - Indra calling - if that's right word! - on my new Thoughtwriter - old one had nervous breakdown ha ha - so be lots of mistakes - no time to edit before I send. Hope you can make sense.

COMSET! Channel one oh three - record from twelve thirty - correction - thirteen thirty. Sorry...

Hope I can get old unit fixed - knew all my short-cuts and abbrevies - maybe should get psychoanalysed like in your time - never understood how that Fraudian - mean Freudian ha ha - nonsense lasted as long as it did - Reminds me - came across late Twentieth defin other day - may amuse you - something like this - quote -Psychoanalysis - contagious disease originating Vienna circa 1900 - now extinct in Europe but occasional outbreaks among rich Americans. Unquote. Funny?

Sorry again - trouble with Thoughtwriters - hard to stick to point -xz
12€w 888 5***** js98l2yebdc DAMN... STOP BACKUP

Did I do something wrong then? Will try again. You mentioned Danil... sorry we always evaded your questions about him - knew you were curious, but we had very good reason - remember you once called him a non-person?... not bad guess...!

Once you asked me about crime nowadays - I said any such interest pathological - maybe prompted by the endless sickening television programmes of your time - never able to watch more than few minutes myself... disgusting!

DOOR ACKNOWLEDGE! OH, HELLO MELINDA EXCUSE SIT DOWN NEARLY FINISHED...

Yes - crime. Always some... Society's irreducible noise level. What to do?

Your solution - prisons. State-sponsored perversion factories - costing ten times average family income to hold one inmate! Utterly crazy... Obviously something very wrong with people who shouted loudest for more prisons - They should be psychoanalysed! But let's be fair - really no alternative before electronic monitoring and control perfected - you should see the joyful crowds smashing the prison walls then - nothing like it since Berlin fifty years earlier!

Yes - Danil. I don't know what his crime was - wouldn't tell you if I did - but presume his psych profile suggested he'd make a good - what was the word? - ballet - no, valet. Very hard to get people for some jobs - don't know how we'd manage if crime level zero! Anyway hope he's soon decontrolled and back in normal society

SORRY MELINDA NEARLY FINISHED

That's it, Frank - regards to Dimitrij - you must be halfway to Ganymede now - wonder if they'll ever repeal Einstein so we can talk across space in real-time!

Hope this machine soon gets used to me. Otherwise be looking round for genuine antique twentieth century word processor... Would you believe - once even mastered that QWERTYIYUIOP nonsense, which you took a couple of hundred years to get rid of?

Love and good-bye.

* * *

Hello Frank - here I am again. Still waiting acknowledgement of my last...

Strange you should be heading towards Ganymede, and my old friend Ted Khan. But perhaps it's not such a coincidence: he was drawn by the same enigma that you were...

First I must tell you something about him. His parents played a dirty trick, giving him the name Theodore. That shortens - don't ever call him that! - to Theo. See what I mean?

Can't help wondering if that's what drives him. Don't know anyone else who's developed such an interest in religion - no, obsession. Better warn you; he can be quite a bore.

By the way, how am I doing? I miss my old Thinkwriter, but seem to be getting this machine under control. Haven't made any bad - what did you call them? - bloopers - glitches - fluffs - so far at least - Not sure I should tell you this, in case you accidentally blurt it out, but my private nickname for Ted is 'The Last Jesuit'. You must know something about them - the Order was still very active in your time.

Amazing people - often great scientists - superb scholars - did a tremendous amount of good as well as much harm. One of history's supreme ironies - sincere and brilliant seekers of knowledge and truth, yet their whole philosophy hopelessly distorted by superstition...

Xuedn2k3jn deer 2leidj dwpp

Damn. Got emotional and lost control. One, two, three, four... now is the time for all good men to come to the aid of the party... that's better.

Anyway, Ted has that same brand of high-minded determination; don't get into any arguments with him - he'll go over you like a steam-roller.

By the way what were steam-rollers? Used for pressing clothes? Can see how that could be very uncomfortable...

Trouble with Thinkwriters... too easy to go off in all directions, no matter how hard you try to discipline yourself... something to be said for keyboards after all... sure I've said that before...

Ted Khan... Ted Khan... Ted Khan

He's still famous back on Earth for at least two of his sayings: 'Civilization and Religion are incompatible' and 'Faith is believing what you know isn't true'. Actually, I don't think the last one is original; if it is, that's the nearest he ever got to a joke. He never cracked a smile when I tried one of my favourites on him - hope you haven't heard it before. It obviously dates from your time.

The Dean's complaining to his Faculty. 'Why do you scientists need such expensive equipment? Why can't you be like the Maths Department, which only needs a blackboard and a waste-paper basket? Better still, like the Department of Philosophy. That doesn't even need a wastepaper

basket...' Well, perhaps Ted had heard it before... I expect most philosophers have...

Anyway, give him my regards - and don't, repeat don't, get into any arguments with him!

Love and best wishes from Africa Tower.

TRANSCRIBE STORE

TRANSMIT POOLE

16

The Captain's Table

The arrival of such a distinguished passenger had caused a certain disruption in the tight little world of Goliath, but the crew had adapted to it with good humour. Every day, at 18.00 hours, all personnel gathered for dinner in the wardroom, which in zero-gee could hold at least thirty people in comfort, if spread uniformly around the walls. However, most of the time the ship's working areas were held at lunar gravity, so there was an undeniable floor - and more than eight bodies made a crowd.

The semi-circular table that unfolded around the auto-chef at mealtimes could just seat the entire seven-person crew, with the Captain at the place of honour. One extra created such insuperable problems that somebody now had to eat alone for every meal. After much good-natured debate, it was decided to make the choice in alphabetical order - not of proper names, which were hardly ever used, but of nicknames. It had taken Poole

some time to get used to them: 'Bolts' (structural engineering); 'Chips' (computers and communications); 'First' (First Mate); 'Life' (medical and life-support systems); 'Props' (propulsion and power); and 'Stars' (orbits and navigation).

During the ten-day voyage, as he listened to the stories, jokes and complaints of his temporary shipmates, Poole learned more about the solar system than during his months on Earth. All aboard were obviously delighted to have a new and perhaps naïve listener as an attentive one-man audience, but Poole was seldom taken in by their more imaginative stories.

Yet sometimes it was hard to know where to draw the line. No one really believed in the Golden Asteroid, which was usually regarded as a twenty-fourth-century hoax. But what about the Mercurian plasmoids, which had been reported by at least a dozen reliable witnesses during the last five hundred years?

The simplest explanation was that they were related to ball-lightning, responsible for so many 'Unidentified Flying Object' reports on Earth and Mars. But some observers swore that they had shown purposefulness - even inquisitiveness - when they were encountered at close quarters. Nonsense, answered the sceptics - merely electrostatic attraction!

Inevitably, this led to discussions about life in the Universe, and Poole found himself - not for the first time - defending his own era against its extremes of credulity and scepticism. Although the 'Aliens are among us' mania had already subsided when he was a boy, even as late as the 2020s the Space Agency was still plagued by lunatics who claimed to have been contacted - or abducted - by visitors from other worlds. Their delusions had been reinforced by sensational media exploitation, and the whole syndrome was later enshrined in the medical literature as 'Adamski's Disease'.

The discovery of TMA ONE had, paradoxically, put an end to this sorry nonsense, by demonstrating that though there was indeed intelligence

elsewhere, it had apparently not concerned itself with Mankind for several million years. TMA ONE had also convincingly refuted the handful of scientists who argued that life above the bacterial level was such an improbable phenomenon that the human race was alone in this Galaxy - if not the Cosmos.

Goliath's crew was more interested in the technology than the politics and economics of Poole's era, and were particularly fascinated by the revolution that had taken place in his own lifetime - the end of the fossil-fuel age, triggered by the harnessing of vacuum energy. They found it hard to imagine the smog-choked cities of the twentieth century, and the waste, greed and appalling environmental disasters of the Oil Age.

'Don't blame me,' said Poole, fighting back gamely after one round of criticism. 'Anyway, see what a mess the twenty-first century made.'

There was a chorus of 'What do you mean?'s around the table.

'Well, as soon as the so-called Age of Infinite Power got under way, and everyone had thousands of kilowatts of cheap, clean energy to play with - you know what happened!'

'Oh, you mean the Thermal Crisis. But that was fixed.'

'Eventually - after you'd covered half the Earth with reflectors to bounce the Sun's heat back into space. Otherwise it would have been as parboiled as Venus by now.'

The crew's knowledge of Third Millennium history was so surprisingly limited that Poole - thanks to the intensive education he had received in Star City - could often amaze them with details of events centuries after his own time. However, he was flattered to discover how well-acquainted they were with Discovery's log, it had become one of the classic records of the Space Age. They looked on it as he might have regarded a Viking

saga; often he had to remind himself that he was midway in time between Goliath and the first ships to cross the western ocean...

'On your Day 86,' Stars reminded him, at dinner on the fifth evening, 'you passed within two thousand kay of asteroid 7794 - and shot a probe into it. Do you remember?'

'Of course I do,' Poole answered rather brusquely 'To me, it happened less than a year ago'

'Um, sorry. Well, tomorrow we'll be even closer to 13,445. Like to have a look?' With autoguidance and freeze-frame, we should have a window all of ten milliseconds wide.'

A hundredth of a second! That few minutes in Discovery had seemed hectic enough, but now everything would happen fifty times faster.

'How large is it?' Poole asked.

'Thirty by twenty by fifteen metres,' Stars replied. 'Looks like a battered brick.'

'Sorry we don't have a slug to fire at it,' said Props. 'Did you ever wonder if 7794 would hit back?'

'Never occurred to us. But it did give the astronomers a lot of useful information, so it was worth the risk... Anyway, a hundredth of a second hardly seems worth the bother. Thanks all the same.'

'I understand. When you've seen one asteroid, you've seen them -'

'Not true, Chips. When I was on Eros -'

'As you've told us at least a dozen times -, Poole's mind tuned out the discussion, so that it was a background of meaningless noise. He was a

thousand years in the past, recalling the only excitement of Discovery's mission before the final disaster. Though he and Bowman were perfectly aware that 7794 was merely a lifeless, airless chunk of rock, that knowledge scarcely affected their feelings. It was the only solid matter they would meet this side of Jupiter, and they had stared at it with the emotions of sailors on a long sea voyage, skirting a coast on which they could not land.

It was turning slowly end over end, and there were mottled patches of light and shade distributed at random over its surface. Sometimes it sparkled like a distant window, as planes or outcroppings of crystalline material flashed in the Sun...

He remembered, also, the mounting tension as they waited to see if their aim had been accurate. It was not easy to hit such a small target, two thousand kilometres away, moving at a relative velocity of twenty kilometres a second.

Then, against the darkened portion of the asteroid, there had been a sudden, dazzling explosion of light. The tiny slug - pure Uranium 238 - had impacted at meteoric speed: in a fraction of a second, all its kinetic energy had been transformed into heat. A puff of incandescent gas had erupted briefly into space, and Discovery's cameras were recording the rapidly fading spectral lines, looking for the tell-tale signatures of glowing atoms. A few hours later, back on Earth, the astronomers learned for the first time the composition of an asteroid's crust. There were no major surprises, but several bottles of champagne changed hands.

Captain Chandler himself took little part in the very democratic discussions around his semi-circular table: he seemed content to let his crew relax and express their feelings in this informal atmosphere. There was only one unspoken rule: no serious business at mealtimes. If there were any technical or operational problems, they had to be dealt with elsewhere.

Poole had been surprised - and a little shocked - to discover that the crew's knowledge of Goliath's systems was very superficial. Often he had asked questions which should have been easily answered, only to be referred to the ship's own memory banks. After a while, however, he realized that the sort of in-depth training he had received in his days was no longer possible: far too many complex systems were involved for any man or woman's mind to master. The various specialists merely had to know what their equipment did, not how. Reliability depended on redundancy and automatic checking, and human intervention was much more likely to do harm than good.

Fortunately none was required on this voyage: it had been as uneventful as any skipper could have hoped, when the new sun of Lucifer dominated the sky ahead.



**THE
WORLDS OF
GALILEO**

(Extract, text only, Tourist's Guide to Outer Solar System, v 219.3)

Even today, the giant satellites of what was once Jupiter present us with major mysteries. Why are four worlds, orbiting the same primary and very similar in size, so different in most other respects?

Only in the case of Io, the innermost satellite, is there a convincing explanation. It is so close to Jupiter that the gravitational tides constantly kneading its interior generate colossal quantities of heat - so much, indeed, that Io's surface is semi-molten. It is the most volcanically active world in the Solar System; maps of Io have a half-life of only a few decades.

Though no permanent human bases have ever been established in such an unstable environment, there have been numerous landings and there is continuous robot monitoring. (For the tragic fate of the 2571 Expedition, see Beagle 5.)

Europa, second in distance from Jupiter, was originally entirely covered in ice, and showed few surface features except a complicated network of cracks. The tidal forces which dominate Io were much less powerful here, but produced enough heat to give Europa a global ocean of liquid water, in which many strange life-forms have evolved.

In 2010 the Chinese ship Tsien touched down on Europa on one of the few outcrops of solid rock protruding through the crust of ice. In doing so it disturbed a creature of the European abyss and was destroyed (see Spacecraft Tsien, Galaxy, Universe).

Since the conversion of Jupiter into the mini-sun Lucifer in 2061, virtually all of Europa's ice-cover has melted, and extensive vulcanism has created several small islands.

As is well-known, there have been no landings on Europa for almost a thousand years, but the satellite is under continuous surveillance.

Ganymede, largest moon in the Solar System (diameter 5260 kilometres), has also been affected by the creation of a new sun, and its equatorial regions are warm enough to sustain terrestrial life-forms, though it does not yet have a breathable atmosphere. Most of its population is actively engaged in terraforming and scientific research; the main settlement is Anubis (pop 41,000), near the South Pole.

Callisto is again wholly different. Its entire surface is covered by impact craters of all sizes, so numerous that they overlap. The bombardment must have continued for millions of years, for the newer craters have completely obliterated the earlier ones. There is no permanent base on Callisto, but several automatic stations have been established there.

17

Ganymede

It was unusual for Frank Poole to oversleep, but he had been kept awake by strange dreams. Past and present were inextricably mixed; sometimes he was on Discovery, sometimes in the Africa Tower - and sometimes he was a boy again, among friends he had thought long-forgotten.

Where am I? he asked himself as he struggled up to consciousness, like a swimmer trying to get back to the surface. There was a small window just above his bed, covered by a curtain not thick enough to completely block the light from outside. There had been a time, around the mid-twentieth century, when aircraft had been slow enough to feature First Class sleeping accommodation: Poole had never sampled this nostalgic

luxury, which some tourist organizations had still advertised in his own day, but he could easily imagine that he was doing so now.

He drew the curtain and looked out. No, he had not awakened in the skies of Earth, though the landscape unrolling below was not unlike the Antarctic. But the South Pole had never boasted two suns, both rising at once as Goliath swept towards them.

The ship was orbiting less than a hundred kilometres above what appeared to be an immense ploughed field, lightly dusted with snow. But the ploughman must have been drunk - or the guidance system must have gone crazy - for the furrows meandered in every direction, sometimes cutting across each other or turning back on themselves. Here and there the terrain was dotted with faint circles -ghost craters from meteor impacts aeons ago.

So this is Ganymede, Poole wondered drowsily. Mankind's furthest outpost from home! Why should any sensible person want to live here? Well, I've often thought that when I've flown over Greenland or Iceland in winter-time...

There was a knock on the door, a 'Mind if I come in?', and Captain Chandler did so without waiting for a reply.

'Thought we'd let you sleep until we landed - that end-of-trip party did last longer than I'd intended, but I couldn't risk a mutiny by cutting it short.'

Poole laughed.

'Has there ever been a mutiny in space?'

'Oh, quite a few but not in my time. Now we've mentioned the subject, you might say that Hal started the tradition... sorry - perhaps I shouldn't - look - there's Ganymede City!'

Coming up over the horizon was what appeared to be a criss-cross pattern of streets and avenues, intersecting almost at right-angles but with the slight irregularity typical of any settlement that had grown by accretion, without central planning. It was bisected by a broad river - Poole recalled that the equatorial regions of Ganymede were now warm enough for liquid water to exist - and it reminded him of an old wood-cut he had seen of medieval London.

Then he noticed that Chandler was looking at him with an expression of amusement... and the illusion vanished as he realized the scale of the 'city'.

'The Ganymedeans,' he said dryly, 'must have been rather large, to have made roads five or ten kilometres wide.'

'Twenty in some places. Impressive, isn't it? And all the result of ice stretching and contracting. Mother Nature is ingenious... I could show you some patterns that look even more artificial, though they're not as large as this one.'

'When I was a boy, there was a big fuss about a face on Mars. Of course, it turned out to be a hill that had been carved by sand-storms... lots of similar ones in Earth's deserts.'

'Didn't someone say that history always repeats itself? Same sort of nonsense happened with Ganymede City - some nuts claimed it had been built by aliens. But I'm afraid it won't be around much longer.'

'Why?' asked Poole in surprise.

'It's already started to collapse, as Lucifer melts the permafrost. You won't recognize Ganymede in another hundred years... there's the edge of Lake Gilgamesh - if you look carefully - over on the right-'

'I see what you mean. What's happening - surely the water's not boiling, even at this low pressure?'

'Electrolysis plant. Don't know how many skillions of kilograms of oxygen a day. Of course, the hydrogen goes up and gets lost - we hope.'

Chandler's voice trailed off into silence. Then he resumed, in an unusually diffident tone: 'All that beautiful water down there - Ganymede doesn't need half of it! Don't tell anyone, but I've been working out ways of getting some to Venus.'

'Easier than nudging comets?'

'As far as energy is concerned, yes - Ganymede's escape velocity is only three klicks per second. And much, much quicker - years instead of decades. But there are a few practical difficulties..

'I can appreciate that. Would you shoot it off by a mass-launcher?'

'Oh no - I'd use towers reaching up through the atmosphere, like the ones on Earth, but much smaller. We'd pump the water up to the top, freeze it down to near absolute zero, and let Ganymede sling it off in the right direction as it rotated. There would be some evaporation loss in transit, but most of it would arrive - what's so funny?'

'Sorry - I'm not laughing at the idea - it makes good sense. But you've brought back such a vivid memory. We used to have a garden sprinkler - driven round and round by its water jets. What you're planning is the same thing - on a slightly bigger scale... using a whole world...'

Suddenly, another image from his past obliterated all else. Poole remembered how, in those hot Arizona days, he and Rikki had loved to chase each other through the clouds of moving mist, from the slowly revolving spray of the garden sprinkler.

Captain Chandler was a much more sensitive man than he pretended to be: he knew when it was time to leave.

'Gotta get back to the bridge,' he said gruffly. 'See you when we land at Anubis.'

18

Grand Hotel

The Grand Ganymede Hotel - inevitably known throughout the Solar System as 'Hotel Grannymede' was certainly not grand, and would be lucky to get a rating of one-and-a-half stars on Earth. As the nearest competition was several hundred million kilometres away, the management felt little need to exert itself unduly.

Yet Poole had no complaints, though he often wished that Danil was still around, to help him with the mechanics of life and to communicate more efficiently with the semi-intelligent devices with which he was surrounded. He had known a brief moment of panic when the door had closed behind the (human) bellboy, who had apparently been too awed by his guest to explain how any of the room's services functioned. After five minutes of fruitless talking to the unresponsive walls, Poole had finally made contact with a system that understood his accent and his commands. What an 'All Worlds' news item it would have made - 'Historic astronaut starves to death, trapped in Ganymede hotel room'!

And there would have been a double irony. Perhaps the naming of the Grannymede's only luxury suite was inevitable, but it had been a real shock to meet an ancient life-size holo of his old shipmate, in full-dress uniform, as he was led into - the Bowman Suite. Poole even recognized

the image: his own official portrait had been made at the same time, a few days before the mission began.

He soon discovered that most of his Goliath crewmates had domestic arrangements in Anubis, and were anxious for him to meet their Significant Others during the ship's planned twenty-day stop. Almost immediately he was caught up in the social and professional life of this frontier settlement, and it was Africa Tower that now seemed a distant dream.

Like many Americans, in their secret hearts, Poole had a nostalgic affection for small communities where everyone knew everyone else - in the real world, and not the virtual one of cyberspace. Anubis, with a resident population less than that of his remembered Flagstaff, was not a bad approximation to this ideal.

The three main pressure domes, each two kilometres in diameter, stood on a plateau overlooking an ice-field which stretched unbroken to the horizon. Ganymede's second sun

- once known as Jupiter - would never give sufficient heat to melt the polar caps. This was the principal reason for establishing Anubis in such an inhospitable spot: the city's foundations were not likely to collapse for at least several centuries.

And inside the domes, it was easy to be completely indifferent to the outside world. Poole, when he had mastered the mechanisms of the Bowman Suite, discovered that he had a limited but impressive choice of environments. He could sit beneath palm trees on a Pacific beach, listening to the gentle murmur of the waves - or, if he preferred, the roar of a tropical hurricane. He could fly slowly along the peaks of the Himalayas, or down the immense canyons of Mariner Valley. He could walk through the gardens of Versailles or down the streets of half a dozen great cities, at several widely spaced times in their history. Even if the Hotel Grannymede was not one of the Solar System's most highly acclaimed

resorts, it boasted facilities which would have astounded all its more famous predecessors on Earth.

But it was ridiculous to indulge in terrestrial nostalgia, when he had come half-way across the Solar System to visit a strange new world. After some experimenting, Poole arranged a compromise, for enjoyment - and inspiration - during his steadily fewer moments of leisure.

To his great regret, he had never been to Egypt, so it was delightful to relax beneath the gaze of the Sphinx - as it was before its controversial 'restoration' - and to watch tourists scrambling up the massive blocks of the Great Pyramid. The illusion was perfect, apart from the no-man's-land where the desert clashed with the (slightly worn) carpet of the Bowman Suite.

The sky, however, was one that no human eyes had seen until five thousand years after the last stone was laid at Giza. But it was not an illusion; it was the complex and ever-changing reality of Ganymede.

Because this world - like its companions - had been robbed of its spin aeons ago by the tidal drag of Jupiter, the new sun born from the giant planet hung motionless in its sky. One side of Ganymede was in perpetual Lucifer-light - and although the other hemisphere was often referred to as the 'Night Land', that designation was as misleading as the much earlier phrase 'The dark side of the Moon'. Like the lunar Farside, Ganymede's 'Night Land' had the brilliant light of old Sol for half of its long day.

By a coincidence more confusing than useful, Ganymede took almost exactly one week - seven days, three hours - to orbit its primary. Attempts to create a 'One Mede day = one Earth week' calendar had generated so much chaos that they had been abandoned centuries ago. Like all the other residents of the Solar System, the locals employed Universal Time, identifying their twenty-four-hour standard days by numbers rather than names.

Since Ganymede's newborn atmosphere was still extremely thin and almost cloudless, the parade of heavenly bodies provided a never-ending spectacle. At their closest, Io and Callisto each appeared about half the size of the Moon as seen from Earth - but that was the only thing they had in common. Io was so close to Lucifer that it took less than two days to race around its orbit, and showed visible movement even in a matter of minutes. Callisto, at over four times Io's distance, required two Mede days - or sixteen Earth ones - to complete its leisurely circuit.

The physical contrast between the two worlds was even more remarkable. Deep-frozen Callisto had been almost unchanged by Jupiter's conversion into a mini-sun: it was still a wasteland of shallow ice craters, so closely packed that there was not a single spot on the entire satellite that had escaped from multiple impacts, in the days when Jupiter's enormous gravity field was competing with Saturn's to gather up the debris of the outer Solar System. Since then, apart from a few stray shots, nothing had happened for several billion years.

On Io, something was happening every week. As a local wit had remarked, before the creation of Lucifer it had been Hell - now it was Hell warmed up.

Often, Poole would zoom into that burning landscape and look into the sulphurous throats of volcanoes that were continually reshaping an area larger than Africa. Sometimes incandescent fountains would soar briefly hundreds of kilometres into space, like gigantic trees of fire growing on a lifeless world.

As the floods of molten sulphur spread out from volcanoes and vents, the versatile element changed through a narrow spectrum of reds and oranges and yellows when, chameleon-like, it was transformed into its vari-coloured allotropes. Before the dawn of the Space Age, no one had ever imagined that such a world existed. Fascinating though it was to observe it from his comfortable vantage point, Poole found it hard to believe that men had ever risked landing there, where even robots feared

to tread... His main interest, however, was Europa, which at its closest appeared almost exactly the same size as Earth's solitary Moon, but raced through its phases in only four days. Though Poole had been quite unconscious of the symbolism when he chose his private landscape, it now seemed wholly appropriate that Europa should hang in the sky above another great enigma - the Sphinx.

Even with no magnification, when he requested the naked-eye view, Poole could see how greatly Europa had changed in the thousand years since Discovery had set out for Jupiter. The spider's web of narrow bands and lines that had once completely enveloped the smallest of the four Galilean satellites had vanished, except around the poles. Here the global crust of kilometre-thick ice remained unmelted by the warmth of Europa's new sun: elsewhere, virgin oceans seethed and boiled in the thin atmosphere, at what would have been comfortable room temperature on Earth.

It was also a comfortable temperature to the creatures who had emerged, after the melting of the unbroken ice shield that had both trapped and protected them. Orbiting spysats, showing details only centimetres across, had watched one European species starting to evolve into an amphibious stage: though they still spent much of their time underwater, the 'Europs' had even begun the construction of simple buildings.

That this could happen in a mere thousand years was astonishing, but no one doubted that the explanation lay in the last and greatest of the Monoliths - the many-kilometre-long 'Great Wall' standing on the shore of the Sea of Galilee.

And no one doubted that, in its own mysterious way, it was watching over the experiment it had started on this world - as it had done on Earth four million years before.

MISS PRINGLE

FILE INDRA

My dear Indra - sorry I've not even voice-mailed you before - usual excuse, of course, so I won't bother to give it.

To answer your question - yes, I'm now feeling quite at home at the Grannymede, but am spending less and less time there, though I've been enjoying the sky display I've had piped into my suite. Last night the Io flux-tube put on a fine performance - that's a kind of lightning discharge between Io and Jupiter - I mean Lucifer. Rather like Earth's aurora, but much more spectacular. Discovered by the radio astronomers even before I was born.

And talking about ancient times - did you know that Anubis has a Sheriff? I think that's overdoing the frontier spirit. Reminds me of the stories my grandfather used to tell me about Arizona... Must try some of them on the Medes...

This may sound silly - I'm still not used to being in the Bowman Suite. I keep looking over my shoulder...

How do I spend my time? Much the same as in Africa Tower. I'm meeting the local intelligentsia, though as you might expect they're rather thin on the ground (hope no one is bugging this). And I've interacted - real and virtual - with the educational system - very good, it seems, though more technically oriented than you'd approve. That's inevitable, of course, in this hostile environment...

But it's helped me to understand why people live here. There's a challenge - a sense of purpose, if you like - that I seldom found on Earth.

It's true that most of the Medes were born here, so don't know any other home. Though they're - usually - too polite to say so, they think that the Home Planet is becoming decadent. Are you? And if so, what are you Terries - as the locals call you - going to do about it? One of the teenage classes I've met hopes to wake you up. They're drawing up elaborate Top Secret plans for the Invasion of Earth. Don't say I didn't warn you...

I've made one trip outside Anubis, into the so-called Night Land, where they never see Lucifer. Ten of us -Chandler, two of Goliath's crew, six Medes - went into Farside, and chased the Sun down to the horizon so it really was night. Awesome - much like polar winters on Earth, but with the sky completely black... almost felt I was in space.

We could see all the Galileans beautifully, and watched Europa eclipse - sorry, occult - Io. Of course, the trip had been timed so we could observe this...

Several of the smaller satellites were just also visible, but the double star Earth-Moon was much more conspicuous. Did I feel homesick? Frankly, no - though I miss my new friends back there...

And I'm sorry - I still haven't met Dr Khan, though he's left several messages for me. I promise to do it in the next few days - Earth days, not Mede ones!

Best wishes to Joe - regards to Danil, if you know what's happened to him - is he a real person again? - and my love to yourself.

STORE TRANSMIT

Back in Poole's century, a person's name often gave a clue to his/her appearance, but that was no longer true thirty generations later. Dr Theodore Khan turned out to be a Nordic blond who might have looked more at home in a Viking longboat than ravaging the steppes of Central Asia: however, he would not have been too impressive in either role, being less than a hundred and fifty centimetres tall. Poole could not resist a little amateur psychoanalysis: small people were often aggressive over-achievers - which, from Indra Wallace's hints, appeared to be a good description of Ganymede's sole resident philosopher. Khan probably needed these qualifications, to survive in such a practically-minded society.

Anubis City was far too small to boast a university campus - a luxury which still existed on the other worlds, though many believed that the telecommunications revolution had made it obsolete. Instead, it had something much more appropriate, as well as centuries older - an Academy, complete with a grove of olive trees that would have fooled Plato himself, until he had attempted to walk through it. Indra's joke about departments of philosophy requiring no more equipment than blackboards clearly did not apply in this sophisticated environment.

'It's built to hold seven people,' said Dr Khan proudly, when they had settled down on chairs obviously designed to be not-too-comfortable, 'because that's the maximum one can efficiently interact with. And, if you count the ghost of Socrates, it was the number present when Phaedo delivered his famous address...'

'The one on the immortality of the soul?'

Khan was so obviously surprised that Poole could not help laughing.

'I took a crash course in philosophy just before I graduated - when the syllabus was planned, someone decided that we hairy-knuckled engineers should be exposed to a little culture.'

'I'm delighted to hear it. That makes things so much easier. You know - I still can't credit my luck. Your arrival here almost tempts me to believe in miracles! I'd even thought of going to Earth to meet you - has dear Indra told you about my - ah - obsession?'

'No,' Poole answered, not altogether truthfully.

Dr Khan looked very pleased; he was clearly delighted to find a new audience.

'You may have heard me called an atheist, but that's not quite true. Atheism is unprovable, so uninteresting. Equally, however unlikely it is, we can never be certain that God once existed - and has now shot off to infinity, where no one can ever find him... Like Gautama Buddha, I take no position on this subject. My field of interest is the psychopathology known as Religion.'

'Psychopathology? That's a harsh judgement.'

'Amplly justified by history. Imagine that you're an intelligent extraterrestrial, concerned only with verifiable truths. You discover a species which has divided itself into thousands - no by now millions - of tribal groups holding an incredible variety of beliefs about the origin of the universe and the way to behave in it. Although many of them have ideas in common, even when there's a ninety-nine per cent overlap, the remaining one per cent is enough to set them killing and torturing each other, over trivial points of doctrine, utterly meaningless to outsiders.'

'How to account for such irrational behaviour? Lucretius hit it on the nail when he said that religion was the by-product of fear - a reaction to a mysterious and often hostile universe. For much of human prehistory, it may have been a necessary evil - but why was it so much more evil than necessary - and why did it survive when it was no longer necessary?'

'I said evil - and I mean it, because fear leads to cruelty. The slightest knowledge of the Inquisition makes one ashamed to belong to the human species... One of the most revolting books ever published was the Hammer of Witches, written by a couple of sadistic perverts and describing the tortures the Church authorized - encouraged! - to extract "confessions" from thousands of harmless old women, before it burned them alive... The Pope himself wrote an approving foreword!'

'But most of the other religions, with a few honourable exceptions, were just as bad as Christianity... Even in your century, little boys were kept chained and whipped until they'd memorized whole volumes of pious gibberish, and robbed of their childhood and manhood to become monks...'

'Perhaps the most baffling aspect of the whole affair is how obvious madmen, century after century, would proclaim that they - and they alone! - had received messages from God. If all the messages had agreed, that would have settled the matter. But of course they were wildly discordant - which never prevented self-styled messiahs from gathering hundreds - sometimes millions - of adherents, who would fight to the death against equally deluded believers of a microscopically differing faith.'

Poole thought it was about time he got a word in edgeways.

'You've reminded me of something that happened in my home-town when I was a kid. A holy man - quote, unquote - set up shop, claimed he could work miracles - and collected a crowd of devotees in next to no time. And they weren't ignorant or illiterate; often they came from the best families. Every Sunday I used to see expensive cars parked round his - ah - temple.'

'The "Rasputin Syndrome", it's been called: there are millions of such cases, all through history, in every country. And about one time in a thousand the cult survives for a couple of generations. What happened in this case?'

'Well, the competition was very unhappy, and did its best to discredit him. Wish I could remember his name - he used a long Indian one - Swami something-or-other - but it turned out he came from Alabama. One of his tricks was to produce holy objects out of thin air, and hand them to his worshippers. As it happened, our local rabbi was an amateur conjuror, and gave public demonstrations showing exactly how it was done. Didn't make the slightest difference - the faithful said that their man's magic was real, and the rabbi was just jealous.'

'At one time, I'm sorry to say, Mother took the rascal seriously - it was soon after Dad had run off, which may have had something to do with it - and dragged me to one of his sessions. I was only about ten, but I thought I'd never seen anyone so unpleasant-looking. He had a beard that could have held several birds' nests, and probably did.'

'He sounds like the standard model. How long did he flourish?'

'Three or four years. And then he had to leave town in a hurry: he was caught running teenage orgies. Of course, he claimed he was using mystical soul-saving techniques. And you won't believe this -

'Try me.'

'Even then, lots of his dupes still had faith in him. Their god could do no wrong, so he must have been framed.'

'Framed?'

'Sorry - convicted by faked evidence - sometimes used by the police to catch criminals, when all else fails.'

'Hmm. Well, your swami was perfectly typical: I'm rather disappointed. But he does help to prove my case -that most of humanity has always been insane, at least some of the time.'

'Rather an unrepresentative sample - one small Flagstaff suburb.'

'True, but I could multiply it by thousands - not only in your century, but all down the ages. There's never been anything, however absurd, that countless people weren't prepared to believe, often so passionately that they'd fight to the death rather than abandon their illusions. To me, that's a good operational definition of insanity.'

'Would you argue that anyone with strong religious beliefs was insane?'

'In a strictly technical sense, yes - if they really were sincere, and not hypocrites. As I suspect ninety per cent were.'

'I'm certain that Rabbi Berenstein was sincere - and he was one of the sanest men I ever knew, as well as one of the finest. And how do you account for this? The only real genius I ever met was Dr Chandra, who led the HAL project. I once had to go into his office - there was no reply when I knocked, and I thought it was unoccupied.'

'He was praying to a group of fantastic little bronze statues, draped with flowers. One of them looked like an elephant... another had more than the regular number of arms... I was quite embarrassed, but luckily he didn't hear me and I tiptoed out. Would you say he was insane?'

'You've chosen a bad example: genius often is! So let's say: not insane, but mentally impaired, owing to childhood conditioning. The Jesuits claimed: "Give me a boy for six years, and he is mine for life." If they'd got hold of little Chandra in time, he'd have been a devout Catholic - not a Hindu.'

'Possibly. But I'm puzzled - why were you so anxious to meet me? I'm afraid I've never been a devout anything. What have I got to do with all this?'

Slowly, and with the obvious enjoyment of a man unburdening himself of a heavy, long-hoarded secret, Dr Khan told him.

20

Apostate

RECORD POOLE

Hello, Frank... So you've finally met Ted. Yes, you could call him a crank - if you define that as an enthusiast with no sense of humour. But cranks often get that way because they know a Big Truth - can, you hear my capitals?

- and no one will listen... I'm glad you did - and I suggest you take him quite seriously.

You said you were surprised to see a Pope's portrait prominently displayed in Ted's apartment. That would have been his hero, Pius XX - I'm sure I mentioned him to you. Look him up - he's usually called the Impius! It's a fascinating story, and exactly parallels something that happened just before you were born. You must know how Mikhail Gorbachev, the President of the Soviet Empire, brought about its dissolution at the end of the twentieth century, by exposing its crimes and excesses.

He didn't intend to go that far - he'd hoped to reform it, but that was no longer possible. We'll never know if Pius XX had the same idea, because he was assassinated by a demented cardinal soon after he'd horrified the world by releasing the secret files of the Inquisition...

The religious were still shaken by the discovery of TMA ZERO only a few decades earlier - that had a great impact on Pius XX, and certainly influenced his actions...

But you still haven't told me how Ted, that old cryptoDeist, thinks you can help him in his search for God. I believe he's still mad at him for hiding so successfully. Better not say I told you that.

On second thoughts, why not?

Love - Indra.

STORE

TRANSMIT

MISS PRINGLE

RECORD

Hello - Indra - I've had another session with Dr Ted, though I've still not told him just why you think he's angry with God!

But I've had some very interesting arguments - no, dialogues - with him, though he does most of the talking. Never thought I'd get into philosophy again after all these years of engineering. Perhaps I had to go through them first, to appreciate it. Wonder how he'd grade me as a student?

Yesterday I tried this line of approach, to see his reaction. Perhaps it's original, though I doubt it. Thought you'd like to hear it - will be interested in your comments. Here's our discussion -MISS PRINGLE COPY AUDIO 94.

'Surely, Ted, you can't deny that most of the greatest works of human art have been inspired by religious devotion. Doesn't that prove something?'

'Yes - but not in a way that will give much comfort to any believers! From time to time, people amuse themselves making lists of the Biggests and Greatests and Bests - I'm sure that was a popular entertainment in your day.'

'It certainly was.'

'Well, there have been some famous attempts to do this with the arts. Of course such lists can't establish absolute - eternal - values, but they're interesting and show how tastes change from age to age.'

'The last list I saw - it was on the Earth Artnet only a few years ago - was divided into Architecture, Music, Visual Arts... I remember a few of the examples... the Parthenon, the Taj Mahal... Bach's Toccata and Fugue was first in music, followed by Verdi's Requiem Mass. In art - the Mona Lisa, of course. Then - not sure of the order - a group of Buddha statues somewhere in Ceylon, and the golden death-mask of young King Tut.

'Even if I could remember all the others - which of course I can't - it doesn't matter: the important thing is their cultural and religious backgrounds. Overall, no single religion dominated - except in music. And that could be due to a purely technological accident: the organ and the other pre-electronic musical instruments were perfected in the Christianized West. It could have worked out quite differently... if, for example, the Greeks or the Chinese had regarded machines as something more than toys.

'But what really settles the argument, as far as I'm concerned, is the general consensus about the single greatest work of human art. Over and over again, in almost every listing - it's Angkor Wat. Yet the religion that

inspired that has been extinct for centuries - no one even knows precisely what it was, except that it involved hundreds of gods, not merely one!

'Wish I could have thrown that at dear old Rabbi Berenstein - I'm sure he'd have had a good answer.'

'I don't doubt it. I wish I could have met him myself. And I'm glad he never lived to see what happened to Israel.'

END AUDIO.

There you have it, Indra. Wish the Grannymede had Angkor Wat on its menu - I've never seen it - but you can't have everything...

Now, the question you really wanted answered... why is Dr Ted so delighted that I'm here?

As you know, he's convinced that the key to many mysteries lies on Europa - where no one has been allowed to land for a thousand years.

He thinks I may be an exception. He believes I have a friend there. Yes - Dave Bowman, or whatever he's now become...

We know that he survived being drawn into the Big Brother Monolith - and somehow revisited Earth afterwards. But there's more, that I didn't know. Very few people do, because the Medes are embarrassed to talk about it...

Ted Khan has spent years collecting the evidence, and is now quite certain of the facts - even though he can't explain them. On at least six occasions, about a century apart, reliable observers here in Anubis have reported seeing an - apparition - just like the one that Heywood Floyd met aboard Discovery. Though not one of them knew about that incident, they were all able to identify Dave when they were shown his hologram. And

there was another sighting aboard a survey ship that made a close approach to Europa, six hundred years ago...

Individually, no one would take these cases seriously - but altogether they make a pattern. Ted's quite sure that Dave Bowman survives in some form, presumably associated with the Monolith we call the Great Wall. And he still has some interest in our affairs.

Though he's made no attempt at communication, Ted hopes we can make contact. He believes that I'm the only human who can do it...

I'm still trying to make up my mind. Tomorrow, I'll talk it over with Captain Chandler. Will let you know what we decide. Love, Frank.

STORE

TRANSMIT INDRA

21

Quarantine

'Do you believe in ghosts, Dim?'

'Certainly not: but like every sensible man, I'm afraid of them. Why do you ask?'

'If it wasn't a ghost, it was the most vivid dream I've ever had. Last night I had a conversation with Dave Bowman.'

Poole knew that Captain Chandler would take him seriously, when the occasion required; nor was he disappointed.

'Interesting - but there's an obvious explanation. You've been living here in the Bowman Suite, for Deus's sake! You told me yourself it feels haunted.'

'I'm sure - well, ninety-nine per cent sure - that you're right, and the whole thing was prompted by the discussions I've been having with Prof. Ted. Have you heard the reports that Dave Bowman occasionally appears in Anubis? About once every hundred years? Just as he did to Dr Floyd aboard Discovery, after she'd been reactivated.'

'What happened there? I've heard vague stories, but never taken them seriously.'

'Dr Khan does - and so do I - I've seen the original recordings. Floyd's sitting in my old chair when a kind of dust-cloud forms behind him, and shapes itself into Dave - though only the head has detail. Then it gives that famous message, warning him to leave.'

'Who wouldn't have? But that was a thousand years ago. Plenty of time to fake it.'

'What would be the point? Khan and I were looking at it yesterday. I'd bet my life it's authentic.'

'As a matter of fact, I agree with you. And I have heard those reports...'

Chandler's voice trailed away, and he looked slightly embarrassed.

'Long time ago, I had a girl-friend here in Anubis. She told me that her grandfather had seen Bowman. I laughed.'

'I wonder if Ted has that sighting on his list. Could you put him in touch with your friend?'

'Er - rather not. We haven't spoken for years. For all I know, she may be on the Moon, or Mars... Anyway, why is Professor Ted interested?'

'That's what I really wanted to discuss with you.'

'Sounds ominous. Go ahead.'

'Ted thinks that Dave Bowman - or whatever he's become - may still exist - up there on Europa.'

'After a thousand years?'

'Well - look at me.'

'One sample is poor statistics, my maths prof. used to say. But go on.'

'It's a complicated story - or maybe a jigsaw, with most of the pieces missing. But it's generally agreed that something crucial happened to our ancestors when that Monolith appeared in Africa, four million years ago. It marks a turning point in prehistory - the first appearance of tools - and weapons - and religion... That can't be pure coincidence. The Monolith must have done something to us - surely it couldn't have just stood there, passively accepting worship...'

'Ted's fond of quoting a famous palaeontologist who said "TMA ZERO gave us an evolutionary kick in the pants". He argues that the kick wasn't in a wholly desirable direction. Did we have to become so mean and nasty to survive? Maybe we did... As I understand him, Ted believes that there's something fundamentally wrong with the wiring of our brains, which makes us incapable of consistent logical thinking. To make matters worse, though all creatures need a certain amount of aggressiveness to survive, we seem to have far more than is absolutely necessary. And no other animal tortures its fellows as we do. Is this an evolutionary accident - a piece of genetic bad luck?'

'It's also widely agreed that TMA ONE was planted on the Moon to keep track of the project - experiment - whatever it was - and to report to Jupiter - the obvious place for Solar System Mission Control. That's why another Monolith - Big Brother - was waiting there. Had been waiting four million years, when Discovery arrived. Agreed so far?'

'Yes; I've always thought that was the most plausible theory.'

'Now for the more speculative stuff. Bowman was apparently swallowed up by Big Brother, yet something of his personality seems to have survived. Twenty years after that encounter with Heywood Floyd in the second Jupiter expedition, they had another contact aboard Universe, when Floyd joined it for the 2061 rendezvous with Halley's Comet. At least, so he tells us in his memoirs - though he was well over a hundred when he dictated them.'

'Could have been senile.'

'Not according to all the contemporary accounts! Also - perhaps even more significant - his grandson Chris had some equally weird experiences when Galaxy made its forced landing on Europa. And, of course, that's where the Monolith - or a Monolith - is, right now! Surrounded by Europeans...'

'I'm beginning to see what Dr Ted's driving at. This is where we came in - the whole cycle's starting over again. The Europans are being groomed for stardom.'

'Exactly - everything fits. Jupiter ignited to give them a sun, to thaw out their frozen world. The warning to us to keep our distance - presumably so that we wouldn't interfere with their development...'

'Where have I heard that idea before? Of course, Frank - it goes back a thousand years - to your own time! "The Prime Directive"! We still get lots of laughs from those old Star Trek programmes.'

'Did I ever tell you I once met some of the actors? They would have been surprised to see me now... And I've always had two thoughts about that non-interference policy. The Monolith certainly violated it with us, back there in Africa. One might argue that did have disastrous results...'

'So better luck next time - on Europa!' Poole laughed, without much humour. 'Khan used those exact words.'

'And what does he think we should do about it? Above all - where do you come into the picture?'

'First of all, we must find what's really happening on Europa - and why. Merely observing it from space is not enough.'

'What else can we do? All the probes the Medes have sent there were blown up, just before landing.'

'And ever since the mission to rescue Galaxy, crew-carrying ships have been diverted by some field of force, which no one can figure out. Very interesting: it proves that whatever is down there is protective, but not malevolent. And - this is the important point - it must have some way of scanning what's on the way. It can distinguish between robots and humans.'

'More than I can do, sometimes. Go on.'

'Well, Ted thinks there's one human being who might make it down to the surface of Europa - because his old friend is there, and may have some influence with the 'powers-that-be.'

Captain Dimitri Chandler gave a long, low whistle.

'And you're willing to risk it?'

'Yes: what have I got to lose?'

'One valuable shuttle craft, if I know what you have in mind. Is that why you've been learning to fly Falcon?'

'Well, now that you mention it... the idea had occurred to me.'

'I'll have to think it over - I'll admit I'm intrigued, but there are lots of problems.'

'Knowing you, I'm sure they won't stand in the way - once you've decided to help me.'

22

Venture

MISS PRINGLE LIST PRIORITY MESSAGES FROM EARTH

RECORD

Dear Indra - I'm not trying to be dramatic, but this may be my last message from Ganymede. By the time you receive it, I will be on my way to Europa.

Though it's a sudden decision - and no one is more surprised than I am - I've thought it over very carefully. As you'll have guessed, Ted Khan is largely responsible... let him do the explaining, if I don't come back. Please don't misunderstand me - in no way do I regard this as a suicide mission! But I'm ninety per cent convinced by Ted's arguments, and he's aroused my curiosity so much that I'd never forgive myself if I turned

down this once-in-a-lifetime opportunity. Maybe I should say once in two lifetimes...

I'm flying Goliath's little one-person shuttle Falcon - how I'd have loved to demonstrate her to my old colleagues back at the Space Administration! Judging by past records, the most likely outcome is that I'll be diverted away from Europa before I can land. Even this will teach me something...

And if it - presumably the local Monolith, the Great Wall - decides to treat me like the robot probes it's zapped in the past, I'll never know. That's a risk I'm prepared to take.

Thank you for everything, and my very best to Joe. Love from Ganymede - and soon, I hope, from Europa.

STORE

TRANSMIT

IV

**THE
KINGDOM
OF
SULPHUR**

'Europa's about four hundred thousand kay from Ganymede at the moment,' Captain Chandler informed Poole.

'If you stepped on the gas - thanks for teaching me that phrase! - Falcon could get you there in an hour. But I wouldn't recommend it: our mysterious friend might be alarmed by anyone coming in that fast.'

'Agreed and I want time to think. I'm going to take several hours, at least. And I'm still hoping...' Poole's voice trailed off into silence.

'Hoping what?'

'That I can make some sort of contact with Dave, or whatever it is, before I attempt to land.'

'Yes, it's always rude to drop in uninvited - even with people you know, let alone perfect strangers like the Europs. Perhaps you should take some gifts - what did the old-time explorers use? I believe mirrors and beads were once popular.'

Chandler's facetious tone did not disguise his real concern, both for Poole and for the valuable piece of equipment he proposed to borrow - and for which the skipper of Goliath was ultimately responsible.

'I'm still trying to decide how we work this. If you come back a hero, I want to bask in your reflected glory. But if you lose Falcon as well as yourself, what shall I say? That you stole the shuttle while we weren't looking? I'm afraid no one would buy that story. Ganymede Traffic Control's very efficient - has to be! If you left without advance notice,

they'd be on to you in a microsec - well, a millisecond. No way you could leave unless I file your flight-plan ahead of time.'

'So this is what I propose to do, unless I think of something better.'

'You're taking Falcon out for a final qualification test - everyone knows you've already soloed. You'll go into a two-thousand-kilometre-high orbit above Europa - nothing unusual about that - people do it all the time, and the local authorities don't seem to object.'

'Estimated total flight time five hours plus or minus ten minutes. If you suddenly change your mind about coming home, no one can do anything about it - at least, no one on Ganymede. Of course, I'll make some indignant noises, and say how astonished I am by such gross navigational errors, etc., etc. Whatever will look best in the subsequent Court of Enquiry.'

'Would it come to that? I don't want to do anything that will get you into trouble.'

'Don't worry - it's time there was a little excitement round here. But only you and I know about this plot; try not to mention it to the crew - I want them to have - what was that other useful expression you taught me? - "plausible deniability".'

'Thanks, Dim - I really appreciate what you're doing. And I hope you'll never have to regret hauling me aboard Goliath, out round Neptune.'

Poole found it hard to avoid arousing suspicion, by the way he behaved towards his new crewmates as they prepared Falcon for what was supposed to be a short, routine flight. Only he and Chandler knew that it might be nothing of the kind.

Yet he was not heading into the totally unknown, as he and Dave Bowman had done a thousand years ago. Stored in the shuttle's memory were high-resolution maps of Europa showing details down to a few metres across. He knew exactly where he wished to go; it only remained to see if he would be allowed to break the centuries-long quarantine.

24

Escape

'Manual control, please.'

'Are you sure, Frank?'

'Quite sure, Falcon... Thank you.'

Illogical though it seemed, most of the human race had found it impossible not to be polite to its artificial children, however simple-minded they might be. Whole volumes of psychology, as well as popular guides (How Not to Hurt Your Computer's Feelings; Artificial Intelligence - Real irritation were two of the best-known titles) had been written on the subject of Man-Machine etiquette. Long ago it had been decided that, however inconsequential rudeness to robots might appear to be, it should be discouraged. All too easily, it could spread to human relationships as well.

Falcon was now in orbit, just as her flight-plan had promised, at a safe two thousand kilometres above Europa. The giant moon's crescent dominated the sky ahead, and even the area not illuminated by Lucifer was so brilliantly lit by the much more distant Sun that every detail was clearly visible. Poole needed no optical aid to see his planned destination, on the still-icy shore of the Sea of Galilee, not far from the skeleton of the first

spacecraft to land on this world. Though the Europeans had long ago removed all its metal components, the ill-fated Chinese ship still served as a memorial to its crew; and it was appropriate that the only 'town' - even if an alien one - on this whole world should have been named 'Tsienville'.

Poole had decided to come down over the Sea, and then fly very slowly towards Tsienville - hoping that this approach would appear friendly, or at least non-aggressive. Though he admitted to himself that this was very naïve, he could think of no better alternative.

Then, suddenly, just as he was dropping below the thousand-kilometre level, there was an interruption - not of the kind he had hoped for, but one which he had been expecting.

'This is Ganymede Control calling Falcon. You have departed from your flight-plan. Please advise immediately what is happening.'

It was hard to ignore such an urgent request, but in the circumstances it seemed the best thing to do.

Exactly thirty seconds later, and a hundred kilometres closer to Europa, Ganymede repeated its message. Once again Poole ignored it - but Falcon did not.

'Are you quite sure you want to do this, Frank?' asked the shuttle. Though Poole knew perfectly well that he was imagining it, he would have sworn there was a note of anxiety in its voice.

'Quite sure, Falcon. I know exactly what I'm doing.'

That was certainly untrue, and any moment now further lying might be necessary, to a more sophisticated audience.

Seldom-activated indicator lights started to flash near the edge of the control board. Poole smiled with satisfaction: everything was going according to plan.

'This is Ganymede Control! Do you receive me, Falcon? You are operating on manual override, so I am unable to assist you. What is happening? You are still descending towards Europa. Please acknowledge immediately.'

Poole began to experience mild twinges of conscience. He thought he recognized the Controller's voice, and was almost certain that it was a charming lady he had met at a reception given by the Mayor, soon after his arrival at Anubis. She sounded genuinely alarmed.

Suddenly, he knew how to relieve her anxiety - as well as to attempt something which he had previously dismissed as altogether too absurd. Perhaps, after all, it was worth a try: it certainly wouldn't do any harm - and it might even work.

'This is Frank Poole, calling from Falcon. I am perfectly OK - but something seems to have taken over the controls, and is bringing the shuttle down towards Europa. I hope you are receiving this - I will continue to report as long as possible.'

Well, he hadn't actually lied to the worried Controller, and one day he hoped he would be able to face her with a clear conscience.

He continued to talk, trying to sound as if he was completely sincere, instead of skirting the edge of truth.

'This is Frank Poole aboard the shuttle Falcon, descending towards Europa. I assume that some outside force has taken charge of my spacecraft, and will be landing it safely.'

'Dave - this is your old shipmate Frank. Are you the entity that is controlling me? I have reason to think that you are on Europa.

'If so - I look forward to meeting you - wherever or whatever you are.'

Not for a moment did he imagine there would be any reply: even Ganymede Control appeared to be shocked into silence.

And yet, in a way, he had an answer. Falcon was still being permitted to descend towards the Sea of Galilee.

Europa was only fifty kilometres below; with his naked eyes Poole could now see the narrow black bar where the greatest of the Monoliths stood guard - if indeed it was doing that - on the outskirts of Tsienville.

No human being had been allowed to come so close for a thousand years.

25

Fire in the Deep

For millions of years it had been an ocean world, its hidden waters protected from the vacuum of space by a crust of ice. In most places the ice was kilometres thick, but there were lines of weakness where it had cracked open and torn apart. Then there had been a brief battle between two implacably hostile elements that came into direct contact on no other world in the Solar System, The war between Sea and Space always ended in the same stalemate; the exposed water simultaneously boiled and froze, repairing the armour of ice.

The seas of Europa would have frozen completely solid long ago without the influence of nearby Jupiter. Its gravity continually kneaded the core of the little world; the forces that convulsed Io were also working there, though with much less ferocity. Everywhere in the deep was evidence of that tug-of-war between planet and satellite, in the continual roar and thunder of submarine earthquakes, the shriek of gases escaping from the interior, the infrasonic pressure waves of avalanches sweeping over the abyssal plains. By comparison with the tumultuous ocean that covered Europa, even the noisy seas of Earth were muted.

Here and there, scattered over the deserts of the deep, were oases that would have amazed and delighted any terrestrial biologist. They extended for several kilometres around tangled masses of pipes and chimneys deposited by mineral brines gushing from the interior. Often they created natural parodies of Gothic castles, from which black, scalding liquids pulsed in a slow rhythm, as if driven by the beating of some mighty heart. And like blood, they were the authentic sign of life itself.

The boiling fluids drove back the deadly cold leaking down from above, and formed islands of warmth on the sea-bed. Equally important, they brought from Europa's interior all the chemicals of life. Such fertile oases, offering food and energy in abundance, had been discovered by the twentieth-century explorers of Earth's oceans. Here they were present on an immensely larger scale, and in far greater variety.

Delicate, spidery structures that seemed to be the analogue of plants flourished in the 'tropical' zones closest to the sources of heat. Crawling among these were bizarre slugs and worms, some feeding on the plants, others obtaining their food directly from the mineral-laden waters around them. At greater distances from the submarine fires around which all these creatures warmed themselves lived sturdier, more robust organisms, not unlike crabs or spiders.

Armies of biologists could have spent lifetimes studying one small oasis. Unlike the Palaeozoic terrestrial seas, the European abyss was not a

stable environment, so evolution had progressed with astonishing speed, producing multitudes of fantastic forms. And all were under the same indefinite stay of execution; sooner or later, each fountain of life would weaken and die, as the forces that powered it moved their focus elsewhere. All across the European sea-bed was evidence of such tragedies; countless circular areas were littered with the skeletons and mineral-encrusted remains of dead creatures, where entire chapters of evolution had been deleted from the book of life. Some had left as their only memorial huge, empty shells like convoluted trumpets, larger than a man. And there were clams of many shapes - bivalves, and even trivalves, as well as spiral stone patterns, many metres across - exactly like the beautiful ammonites that disappeared so mysteriously from Earth's oceans at the end of the Cretaceous Period.

Among the greatest wonders of the European abyss were rivers of incandescent lava, pouring from the calderas of submarine volcanoes. The pressure at these depths was so great that the water in contact with the red-hot magma could not flash into steam, so the two liquids co-existed in an uneasy truce.

There, on another world and with alien actors, something like the story of Egypt had been played out long before the coming of Man. As the Nile had brought life to a narrow ribbon of desert, so this river of warmth had vivified the European deep. Along its banks, in a band never more than a few kilometres wide, species after species had evolved and flourished and passed away. And some had left permanent monuments.

Often, they were not easy to distinguish from the natural formations around the thermal vents, and even when they were clearly not due to pure chemistry, one would be hard put to decide whether they were the product of instinct or intelligence. On Earth, the termites reared condominiums almost as impressive as any found in the single vast ocean that enveloped this frozen world.

Along the narrow band of fertility in the deserts of the deep, whole cultures and even civilizations might have risen and fallen, armies might have marched - or swum - under the command of European Tamberlanes or Napoleons. And the rest of their world would never have known, for all their oases were as isolated from one another as the planets themselves, The creatures who basked in the glow of the lava rivers, and fed around the hot vents, could not cross the hostile wilderness between their lonely islands. If they had ever produced historians and philosophers, each culture would have been convinced that it was alone in the Universe.

Yet even the space between the oases was not altogether empty of life; there were hardier creatures who had dared its rigours. Some were the European analogues of fish - streamlined torpedoes, propelled by vertical tails, steered by fins along their bodies. The resemblance to the most successful dwellers in Earth's oceans was inevitable; given the same engineering problems, evolution must produce very similar answers. Witness the dolphin and the shark - superficially almost identical, yet from far distant branches of the tree of life.

There was, however, one very obvious difference between the fish of the European seas and those in terrestrial oceans; they had no gills, for there was hardly a trace of oxygen to be extracted from the waters in which they swam. Like the creatures around Earth's own geothermal vents, their metabolism was based on sulphur compounds, present in abundance in this volcanic environment.

And very few had eyes. Apart from the flickering glow of lava outpourings, and occasional bursts of bioluminescence from creatures seeking mates, or hunters questing prey, it was a lightless world.

It was also a doomed one. Not only were its energy sources sporadic and constantly shifting, but the tidal forces that drove them were steadily weakening. Even if they developed true intelligence, the Europeans were trapped between fire and ice.

Barring a miracle, they would perish with the final freezing of their little world.

Lucifer had wrought that miracle.

26

Tsienville

In the final moments, as he came in over the coast at a sedate hundred kilometres an hour, Poole wondered if there might be some last-minute intervention. But nothing untoward happened, even when he moved slowly along the black, forbidding face of the Great Wall.

It was the inevitable name for the Europa Monolith as, unlike its little brothers on Earth and Moon, it was lying horizontally, and was more than twenty kilometres long. Although it was literally billions of times greater in volume than TMA ZERO and TMA ONE, its proportions were exactly the same - that intriguing ratio 1:4:9, inspirer of so much numerological nonsense over the centuries.

As the vertical face was almost ten kilometres high, one plausible theory maintained that among its other functions the Great Wall served as a wind-break, protecting Tsienville from the ferocious gales that occasionally roared in from the Sea of Galilee. They were much less frequent now that the climate had stabilized, but a thousand years earlier they would have been a severe discouragement to any life-forms emerging from the ocean.

Though he had fully intended to do so, Poole had never found time to visit the Tycho Monolith - still Top Secret when he had left for Jupiter - and Earth's gravity made its twin at Olduvai inaccessible to him. But he

had seen their images so often that they were much more familiar than the proverbial back of the hand (and how many people, he had often wondered, would recognize the backs of their hands?). Apart from the enormous difference in scale, there was absolutely no way of distinguishing the Great Wall from TMA ONE and TMA ZERO - or, for that matter, the 'Big Brother' Monolith that Discovery and the Leonov had encountered orbiting Jupiter.

According to some theories, perhaps crazy enough to be true, there was only one archetypal Monolith, and all the others - whatever their size - were merely projections or images of it. Poole recalled these ideas when he noticed the spotless, unsullied smoothness of the Great Wall's towering ebon face. Surely, after so many centuries in such a hostile environment, it should have collected a few patches of grime! Yet it looked as immaculate as if an army of window-cleaners had just polished every square centimetre.

Then he recalled that although everyone who had ever come to view TMA ONE and TMA ZERO felt an irresistible urge to touch their apparently pristine surfaces, no one had ever succeeded. Fingers - diamond drills - laser knives - all skittered across the Monoliths as if they were coated by an impenetrable film. Or as if - and this was another popular theory - they were not quite in this universe, but somehow separated from it by an utterly impassable fraction of a millimetre.

He made one complete, leisurely circuit of the Great Wall, which remained totally indifferent to his progress. Then he brought the shuttle - still on manual, in case Ganymede Control made any further attempts to 'rescue' him - to the outer limits of Tsienville, and hovered there looking for the best place to land.

The scene through Falcon's small panoramic window was wholly familiar to him; he had examined it so often in Ganymede recordings, never imagining that one day he would be observing it in reality. The Europs, it seemed, had no idea of town planning; hundreds of

hemispherical structures were scattered apparently at random over an area about a kilometre across. Some were so small that even human children would feel cramped in them; though others were big enough to hold a large family, none was more than five metres high.

And they were all made from the same material, which gleamed a ghostly white in the double daylight. On Earth, the Esquimaux had found the identical answer to the challenge of their own frigid, materials-poor environment; Tsienville's igloos were also made of ice.

In lieu of streets, there were canals - as best suited creatures who were still amphibious, and apparently returned to the water to sleep. Also, it was believed, to feed and to mate, though neither hypothesis had been proved.

Tsienville had been called 'Venice, made of ice', and Poole had to agree that it was an apt description. However, there were no Venetians in sight; the place looked as if it had been deserted for years.

And here was another mystery; despite the fact that Lucifer was fifty times brighter than the distant Sun, and was a permanent fixture in the sky, the Europs still seemed locked to an ancient rhythm of night and day. They returned to the ocean at sunset, and emerged with the rising of the Sun - despite the fact that the level of illumination had changed by only a few per cent. Perhaps there was a parallel on Earth, where the life cycles of many creatures were controlled as much by the feeble Moon as the far more brilliant Sun.

It would be sunrise in another hour, and then the inhabitants of Tsienville would return to land and go about their leisurely affairs - as by human standards, they certainly were. The sulphur-based biochemistry that powered the Europs was not as efficient as the oxygen-driven one that energized the vast majority of terrestrial animals. Even a sloth could outrun a Europ, so it was difficult to regard them as potentially dangerous. That was the Good News; the Bad News was that even with the best

intentions on both sides, attempts at communication would be extremely slow - perhaps intolerably tedious.

It was about time, Poole decided, that he reported back to Ganymede Control. They must be getting very anxious, and he wondered how his co-conspirator, Captain Chandler, was dealing with the situation.

'Falcon calling Ganymede. As you can doubtless see, I have - er - been brought to rest just above Tsienville. There is no sign of hostility, and as it's still solar night here all the Europs are underwater. Will call you again as soon as I'm on the ground.'

Dim would have been proud of him, Poole thought, as he brought Falcon down gently as a snowflake on a smooth patch of ice. He was taking no chances with its stability, and set the inertial drive to cancel all but a fraction of the shuttle's weight - just enough, he hoped, to prevent it being blown away by any wind.

He was on Europa - the first human in a thousand years. Had Armstrong and Aldrin felt this sense of elation, when Eagle touched down on the Moon? Probably they were too busy checking their Lunar Module's primitive and totally unintelligent systems. Falcon, of course, was doing all this automatically. The little cabin was now very quiet, apart from the inevitable - and reassuring - murmur of well-tempered electronics. It gave Poole a considerable shock when Chandler's voice, obviously pre-recorded, interrupted his thoughts.

'So you made it! Congratulations! As you know, we're scheduled to return to the Belt week after next, but that should give you plenty of time.'

'After five days, Falcon knows what to do. She'll find her way home, with or without you. So good luck!'

MISS PRINGLE

ACTIVATE CRYPTO PROGRAM

STORE

Hello, Dim - thanks for that cheerful message! I feel rather silly using this program - as if I'm a secret agent in one of the spy melodramas that used to be so popular before I was born. Still, it will allow some privacy, which may be useful. Hope Miss Pringle has downloaded it properly... of course, Miss P, I'm only joking!

By the way, I'm getting a barrage of requests from all the news media in the Solar System. Please try to hold them off - or divert them to Dr Ted. He'll enjoy handling them...

Since Ganymede has me on camera all the time, I won't waste breath telling you what I'm seeing. If all goes well, we should have some action in a few minutes - and we'll know if it really was a good idea to let the Europs find me already sitting here peacefully, waiting to greet them when they come to the surface...

Whatever happens, it won't be as big a surprise to me as it was to Dr Chang and his colleagues, when they landed here a thousand years ago! I played his famous last message again, just before leaving Ganymede. I must confess it gave me an eerie feeling - couldn't help wondering if something like that could possibly happen again... wouldn't like to immortalize myself the way poor Chang did...

Of course, I can always lift off if something starts going wrong... and here's an interesting thought that's just occurred to me... I wonder if the Europs have any history - any kind of records... any memory of what happened just a few kilometres from here, a thousand years ago?

...This is Dr Chang, calling from Europa. I hope you can hear me, especially Dr Floyd - I know you're aboard Leonov... I may not have much time... aiming my suit antenna where I think you are... please relay this information to Earth.

Tsien was destroyed three hours ago. I'm the only survivor. Using my suit radio - no idea if it has enough range, but it's the only chance. Please listen carefully...

THERE IS LIFE ON EUROPA. I repeat: THERE IS LIFE ON EUROPA...

We landed safely, checked all the systems, and ran out the hoses so we could start pumping water into our propellant tanks immediately... just in case we had to leave in a hurry.

Everything was going according to plan... it seemed almost too good to be true. The tanks were half full when Dr Lee and I went out to check the pipe insulation. Tsien stands - stood - about thirty metres from the edge of the Grand Canal. Pipes went directly from it and down through the ice. Very thin - not safe to walk on.

Jupiter was quarter full, and we had five kilowatts of lighting strung up on the ship. She looked like a Christmas tree - beautiful, reflected on the ice...

Lee saw it first - a huge dark mass rising up from the depths. At first we thought it was a school of fish - too large for a single organism - then it started to break through the ice, and began moving towards us.

It looked rather like huge strands of wet seaweed, crawling along the ground. Lee ran back to the ship to get a camera - I stayed to watch, reporting over the radio. The thing moved so slowly I could easily outrun it. I was much more excited than alarmed. Thought I knew what kind of creature it was - I've seen pictures of the kelp forests off California - but I was quite wrong.

I could tell it was in trouble. It couldn't possibly survive at a temperature a hundred and fifty below its normal environment. It was freezing solid as it moved forward - bits were breaking off like glass - but it was still advancing towards the ship, a black tidal wave, slowing down all the time.

I was still so surprised that I couldn't think straight and I couldn't imagine what it was trying to do. Even though it was heading towards Tsien it still seemed completely harmless, like - well, a small forest on the move. I remember smiling - it reminded me of Macbeth's Birnam Wood...

Then I suddenly realized the danger. Even if it was completely inoffensive - it was heavy - with all the ice it was carrying, it must have weighed several tons, even in this low gravity.

And it was slowly, painfully climbing up our landing gear... the legs were beginning to buckle, all in slow motion, like something in a dream - or a nightmare...

Not until the ship started to topple did I realize what the thing was trying to do - and then it was far too late. We could have saved ourselves - if we'd only switched off our lights!

Perhaps it's a phototrope, its biological cycle triggered by the sunlight that filters down through the ice. Or it could have been attracted like a moth to a candle. Our floodlights must have been more brilliant than anything that Europa has ever known, even the Sun itself...

Then the ship crashed. I saw the hull split, a cloud of snowflakes form as moisture condensed. All the lights went out, except for one, swinging back and forth on a cable a couple of metres above the ground.

I don't know what happened immediately after that. The next thing I remember, I was standing under the light, beside the wreck of the ship, with a fine powdering of fresh snow all around me. I could see my footsteps in it very clearly. I must have run there; perhaps only a minute or two had elapsed...

The plant - I still thought of it as a plant - was motionless. I wondered if it had been damaged by the impact; large sections - as thick as a man's arms - had splintered off, like broken twigs.

Then the main trunk started to move again. It pulled away from the hull, and began to crawl towards me. That was when I knew for certain that the thing was light-sensitive: I was standing immediately under the thousand-watt lamp, which had stopped swinging now.

Imagine an oak tree - better still, a banyan with its multiple trunks and roots - flattened out by gravity and trying to creep along the ground. It got to within five metres of the light, then started to spread out until it had made a perfect circle around me. Presumably that was the limit of its tolerance - the point at which photo-attraction turned to repulsion.

After that, nothing happened for several minutes, I wondered if it was dead - frozen solid at last.

Then I saw that large buds were forming on many of the branches. It was like watching a time-lapse film of flowers opening. In fact I thought they were flowers - each about as big as a man's head.

Delicate, beautifully coloured membranes started to unfold. Even then, it occurred to me that no one - no thing - could ever have seen these

colours properly, until we brought our lights - our fatal lights - to this world.

Tendrils, stamens, waving feebly... I walked over to the living wall that surrounded me, so that I could see exactly what was happening. Neither then, or at any other time, had I felt the slightest fear of the creature. I was certain that it was not malevolent - if indeed it was conscious at all.

There were scores of the big flowers, in various stages of unfolding. Now they reminded me of butterflies, just emerging from the chrysalis - wings crumpled, still feeble - I was getting closer and closer to the truth.

But they were freezing - dying as quickly as they formed. Then, one after another, they dropped off from the parent buds. For a few moments they flopped around like fish stranded on dry land - and at last I realized exactly what they were. Those membranes weren't petals - they were fins, or their equivalent. This was the free-swimming larval stage of the creature. Probably it spends much of its life rooted on the sea-bed, then sends these mobile offspring in search of new territory. Just like the corals of Earth's oceans.

I knelt down to get a closer look at one of the little creatures. The beautiful colours were fading now, to a drab brown. Some of the petal-fins had snapped off, becoming brittle shards as they froze. But it was still moving feebly, and as I approached it tried to avoid me. I wondered how it sensed my presence.

Then I noticed that the stamens - as I'd called them -all carried bright blue dots at their tips. They looked like tiny star sapphires - or the blue eyes along the mantle of a scallop - aware of light, but unable to form true images. As I watched, the vivid blue faded, the gems became dull, ordinary stones...

Dr Floyd - or anyone else who is listening - I haven't much more time; my life-support system alarm has just sounded. But I've almost finished.

I knew then what I had to do. The cable to that thousand-watt lamp was hanging almost to the ground. I gave it a few tugs, and the light went out in a shower of sparks.

I wondered whether it was too late. For a few minutes nothing happened. So I walked over to the wall of tangled branches around me - and kicked it.

Slowly, the creature started to unweave itself, and to retreat back to the Canal. I followed it all the way back to the water, encouraging it with more kicks when it slowed down, feeling the fragments of ice crunching all the time beneath my boots... As it neared the Canal, it seemed to gain strength and energy, as if it knew it was approaching its natural home. I wondered if it would survive, to bud again.

It disappeared through the surface, leaving a few last dead larvae on the alien land. The exposed free water bubbled for a few minutes until a scab of protective ice sealed it from the vacuum above. Then I walked back to the ship to see if there was anything to salvage - I don't want to talk about that.

I've only two requests to make, Doctor. When the taxonomists classify this creature, I hope they'll name it after me.

And - when the next ship comes home - ask them to take our bones back to China.

I'll lose power in a few minutes - wish I knew whether anyone was receiving me. Anyway, I'll repeat this message as long as I can...

This is Professor Chang on Europa, reporting the destruction of the spaceship Tsien. We landed beside the Grand Canal and set up our pumps at the edge of the ice -

MISS PRINGLE RECORD

Here comes the Sun! Strange - how quickly it seems to rise, on this slowly turning world! Of course, of course - the disc's so small that the whole of it pops above the horizon in no time... Not that it makes much difference to the light - if you weren't looking in that direction, you'd never notice that there was another sun in the sky.

But I hope the Europs have noticed. Usually it takes them less than five minutes to start coming ashore after the Little Dawn. Wonder if they already know I'm here, and are scared...

No - could be the other way round. Perhaps they're inquisitive - even anxious to see what strange visitor has come to Tsienville... I rather hope so...

Here they come! Hope your spysats are watching - Falcon's cameras recording...

How slowly they move! I'm afraid it's going to be very boring trying to communicate with them... even if they want to talk to me...

Rather like the thing that overturned Tsien, but much smaller... They remind me of little trees, walking on half a dozen slender trunks. And with hundreds of branches, dividing into twigs, which divide again... and again. Just like many of our general-purpose robots... what a long time it took us to realize that imitation humanoids were ridiculously clumsy, and the proper way to go was with myriad of small manipulators! Whenever we

invent something clever, we find that Mother Nature's already thought of it...

Aren't the little ones cute - like tiny bushes on the move. Wonder how they reproduce - budding? I hadn't realized how beautiful they are. Almost as colourful as coral reef fish - maybe for the same reasons... to attract mates, or fool predators by pretending to be something else...

Did I say they looked like bushes? Make that rose-bushes - they've actually got thorns! Must have a good reason for them...

I'm disappointed. They don't seem to have noticed me. They'll all heading into town, as if a visiting spacecraft was an everyday occurrence... only a few left... maybe this will work...

I suppose they can detect sound vibrations - most marine creatures can - though this atmosphere may be too thin to carry my voice very far...

FALCON - EXTERNAL SPEAKER...

HELLO, CAN YOU HEAR ME? MY NAME IS FRANK POOLE...
AHM... I COME IN PEACE FOR ALL MANKIND...

Makes me feel rather stupid, but can you suggest anything better? And it will be good for the record...

Nobody's taking the slightest notice. Big ones and little ones, they're all creeping towards their igloos. Wonder what they actually do when they get there - perhaps I should follow. I'm sure it would be perfectly safe - I can move so much faster - I've just had an amusing flashback. All these creatures going in the same direction - they look like the commuters who used to surge back and forth twice a day between home and office, before electronics made it unnecessary. Let's try again, before they all disappear.

HELLO THERE THIS IS FRANK POOLE, A VISITOR FROM
PLANET EARTH. CAN YOU HEAR ME?

I HEAR YOU, FRANK. THIS IS DAVE.

29

The Ghosts in the Machine

Frank Poole's immediate reaction was one of utter astonishment, followed by overwhelming joy. He had never really believed that he would make any kind of contact, either with the Europs or the Monolith. Indeed, he had even had fantasies of kicking in frustration against that towering ebon wall and shouting angrily, 'Is there anybody home?'

Yet he should not have been so amazed: some intelligence must have monitored his approach from Ganymede, and permitted him to land. He should have taken Ted Khan more seriously.

'Dave,' he said slowly, 'is that really you?'

Who else could it be? a part of his mind asked. Yet it was not a foolish question. There was something curiously mechanical - impersonal about the voice that came from the small speaker on Falcon's control board.

YES, FRANK. I AM DAVE.

There was a very brief pause: then the same voice continued, without any change of intonation:

HELLO FRANK. THIS IS HAL.

MISS PRINGLE

RECORD

Well - Indra, Dim - I'm glad I recorded all that, otherwise you'd never believe me...

I guess I'm still in a state of shock. First of all, how should I feel about someone who tried to - who did - kill me - even if it was a thousand years ago! But I understand now that Hal wasn't to blame; nobody was. There's a very good piece of advice I've often found useful 'Never attribute to malevolence what is merely due to incompetence' I can't feel any anger towards a bunch of programmers I never knew, who've been dead for centuries.

I'm glad this is encrypted, as I don't know how it should be handled, and a lot that I tell you may turn out to be complete nonsense. I'm already suffering from information overload, and had to ask Dave to leave me for a while - after all the trouble I've gone through to meet him! But I don't think I hurt his feelings: I m not sure yet if he has any feelings...

What is he - good question! Well, he really is Dave Bowman, but with most of the humanity stripped away - like - ah - like the synopsis of a book or a technical paper. You know how an abstract can give all the basic information but no hint of the author's personality? Yet there were moments when I felt that something of the old Dave was still there. I wouldn't go so far as to say he's pleased to meet me again - moderately satisfied might be more like it... For myself, I'm still very confused. Like meeting an old friend after a long separation, and finding that they're now a different person. Well, it has been a thousand years - and I can't imagine

what experiences he's known, though as I'll show you presently, he's tried to share some of them with me.

And Hal - he's here too, without question. Most of the time, there's no way I can tell which of them is speaking to me. Aren't there examples of multiple personalities in the medical records? Maybe it's something like that.

I asked him how this had happened to them both, and he - they - dammit, Halman! - tried to explain. Let me repeat - I may have got it partly wrong, but it's the only working hypothesis I have.

Of course, the Monolith - in its various manifestations - is the key - no, that's the wrong word - didn't someone once say it was a kind of cosmic Swiss Army knife? You still have them, I've noticed, though both Switzerland and its army disappeared centuries ago. It's a general-purpose device that can do anything it wants to. Or was programmed to do...

Back in Africa, four million years ago, it gave us that evolutionary kick in the pants, for better or for worse. Then its sibling on the Moon waited for us to climb out of the cradle. That we've already guessed, and Dave's confirmed it.

I said that he doesn't have many human feelings, but he still has curiosity - he wants to learn. And what an opportunity he's had!

When the Jupiter Monolith absorbed him - can't think of a better word - it got more than it bargained for. Though it used him - apparently as a captured specimen, and a probe to investigate Earth - he's also been using it. With Hal's assistance - and who should understand a super-computer better than another one? - he's been exploring its memory, and trying to find its purpose.

Now, this is something that's very hard to believe. The Monolith is a fantastically powerful machine - look what it did to Jupiter! - but it's no

more than that. It's running on automatic - it has no consciousness. I remember once thinking that I might have to kick the Great Wall and shout 'Is there anyone there?' And the correct answer would have to be - no one, except Dave and Hal...

Worse still, some of its systems may have started to fail; Dave even suggests that, in a fundamental way, it's become stupid! Perhaps it's been left on its own for too long - it's time for a service check.

And he believes the Monolith has made at least one misjudgement. Perhaps that's not the right word - it may have been deliberate, carefully considered...

In any event, it's - well, truly awesome, and terrifying in its implications. Luckily, I can show it to you, so you can decide for yourselves. Yes, even though it happened a thousand years ago, when Leonov flew the second mission to Jupiter! And all this time, no one has ever guessed...

I'm certainly glad you got me fitted with the Braincap. Of course it's been invaluable - I can't imagine life without it - but now it's doing a job it was never designed for. And doing it remarkably well.

It took Halman about ten minutes to find how it worked, and to set up an interface. Now we have mind-to-mind contact - which is quite a strain on me, I can tell you. I have to keep asking them to slow down, and use baby-talk. Or should I say baby-think...

I'm not sure how well this will come through. It's a thousand-year-old recording of Dave's own experience, somehow stored in the Monolith's enormous memory, then retrieved by Dave and injected into my Braincap - don't ask me exactly how - and finally transferred and beamed to you by Ganymede Central. Phew. Hope you don't get a headache downloading it.

Over to Dave Bowman at Jupiter, early twenty-first century...

The million-kilometre-long tendrils of magnetic force, the sudden explosion of radio waves, the geysers of electrified plasma wider than the planet Earth - they were as real and clearly visible to him as the clouds banding the planet in multi-hued glory. He could understand the complex pattern of their interactions, and realized that Jupiter was much more wonderful than anyone had ever guessed.

Even as he fell through the roaring heart of the Great Red Spot, with the lightning of its continent-wide thunderstorms detonating under him, he knew why it had persisted for centuries though it was made of gases far less substantial than those that formed the hurricanes of Earth. The thin scream of hydrogen wind faded as he sank into the calmer depths, and a sheet of waxy snowflakes - some already coalescing into barely palpable mountains of hydrocarbon foam - descended from the heights above. It was already warm enough for liquid water to exist, but there were no oceans there; this purely gaseous environment was too tenuous to support them.

He descended through layer after layer of cloud, until he entered a region of such clarity that even human vision could have scanned an area more than a thousand kilometres across. It was only a minor eddy in the vaster gyre of the Great Red Spot; and it held a secret that men had long guessed, but never proved. Skirting the foothills of the drifting foam mountains were myriad of small, sharply defined clouds, all about the same size and patterned with similar red and brown mottling. They were small only as compared with the inhuman scale of their surroundings; the very least would have covered a fair-sized city.

They were clearly alive, for they were moving with slow deliberation along the flanks of the aerial mountains, browsing off their slopes like colossal sheep. And they were calling to each other in the metre band, their radio voices faint but clear against the cracklings and concussions of Jupiter itself.

Nothing less than living gasbags, they floated in the narrow zone between freezing heights and scorching depths. Narrow, yes - but a domain far larger than all the biosphere of Earth.

They were not alone. Moving swiftly among them were other creatures so small that they could easily have been overlooked. Some of them bore an almost uncanny resemblance to terrestrial aircraft, and were of about the same size. But they too were alive - perhaps predators, perhaps parasites, perhaps even herdsmen.

A whole new chapter of evolution, as alien as that which he had glimpsed on Europa, was opening before him. There were jet-propelled torpedoes like the squids of the terrestrial oceans, hunting and devouring the huge gas-bags. But the balloons were not defenceless; some of them fought back with electric thunderbolts and with clawed tentacles like kilometre-long chainsaws.

There were even stranger shapes, exploiting almost every possibility of geometry - bizarre, translucent kites, tetrahedra, spheres, polyhedra, tangles of twisted ribbons... The gigantic plankton of the Jovian atmosphere, they were designed to float like gossamer in the uprising currents, until they had lived long enough to reproduce; then they would be swept down into the depths to be carbonized and recycled in a new generation.

He was searching a world more than a hundred times the area of Earth, and though he saw many wonders, nothing there hinted of intelligence. The radio voices of the great balloons carried only simple messages of

warning or of fear. Even the hunters, who might have been expected to develop higher degrees of organization, were like the sharks in Earth's oceans - mindless automata.

And for all its breathtaking size and novelty, the biosphere of Jupiter was a fragile world, a place of mists and foam, of delicate silken threads and paper-thin tissues spun from the continual snowfall of petrochemicals formed by lightning in the upper atmosphere. Few of its constructs were more substantial than soap bubbles; its most awesome predators could be torn to shreds by even the feeblest of terrestrial carnivores.

Like Europa, but on a vastly grander scale, Jupiter was an evolutionary cul-de-sac. Intelligence would never emerge here; even if it did, it would be doomed to a stunted existence. A purely aerial culture might develop, but in an environment where fire was impossible, and solids scarcely existed, it could never even reach the Stone Age.

31

Nursery

MISS PRINGLE RECORD

Well, Indra - Dim - I hope that came through in good shape - I still find it hard to believe. All those fantastic creatures - surely we should have detected their radio voices, even if we couldn't understand them! - wiped out in a moment, so that Jupiter could be made into a sun.

And now we can understand why. It was to give the Europs their chance. What pitiless logic: is intelligence the only thing that matters? I can see some long arguments with Ted Khan over this - The next question is: will the Europs make the grade - or will they remain forever stuck in

the kindergarten - not even that - the nursery? Though a thousand years is a very short time, one would have expected some progress, but according to Dave they're exactly the same now as when they left the sea. Perhaps that's the trouble; they still have one foot - or one twig! - in the water.

And here's another thing we got completely wrong. We thought they went back into the water to sleep. It's just the other way round - they go back to eat, and sleep when they come on land! As we might have guessed from their structure - that network of branches - they're plankton feeders...

I asked Dave about the igloos they've built. Aren't they a technological advance? And he said: not really - they're only adaptations of structures they make on the sea-bed, to protect themselves from various predators - especially something like a flying carpet, as big as a football field...

There's one area, though, where they have shown initiative - even creativity. They're fascinated by metals, presumably because they don't exist in pure form in the ocean. That's why Tsien was stripped - the same thing's happened to the occasional probes that have come down in their territory. What do they do with the copper and beryllium and titanium they collect? Nothing useful, I'm afraid. They pile it all together in one place, in a fantastic heap that they keep reassembling. They could be developing an aesthetic sense - I've seen worse in the Museum of Modern Art... But I've got another theory - did you ever hear of cargo cults? During the twentieth century, some of the few primitive tribes that still existed made imitation aeroplanes out of bamboo, in the hope of attracting the big birds in the sky that occasionally brought them wonderful gifts. Perhaps the Europs have the same idea.

Now that question you keep asking me... What is Dave? And how did he - and Hal - become whatever it is they are now?

The quick answer, of course, is that they're both emulations - simulations - in the Monolith's gigantic memory. Most of the time they're inactivated; when I asked Dave about this, he said he'd been 'awake' - his

actual word -for only fifty years altogether, in the thousand since his - er - metamorphosis.

When I asked if he resented this takeover of his life, he said, 'Why should I resent it? I am performing my functions perfectly.' Yes, that sounds exactly like Hal! But I believe it was Dave - if there's any distinction now.

Remember that Swiss Army knife analogy? Halman is one of this cosmic knife's myriad of components.

But he's not a completely passive tool - when he's awake, he has some autonomy, some independence - presumably within limits set by the Monolith's overriding control. During the centuries, he's been used as a kind of intelligent probe to examine, Jupiter - as you've just seen - as well as Ganymede and the Earth. That confirms those mysterious events in Florida, reported by Dave's old girl-friend, and the nurse who was looking after his mother, just moments before her death... as well as the encounters in Anubis City.

And it also explains another mystery. I asked Dave directly: why was I allowed to land on Europa, when everyone else has been turned away for centuries? I fully expected to be!

The answer's ridiculously simple. The Monolith uses Dave - Halman - from time to time, to keep an eye on us.

Dave knew all about my rescue - even saw some of the media interviews I made, on Earth and on Ganymede. I must say I'm still a little hurt he made no attempt to contact me! But at least he put out the Welcome mat when I did arrive...

Dim - I still have forty-eight hours before Falcon leaves - with or without me! I don't think I'll need them, now I've made contact with

Halman; we can keep in touch just as easily from Anubis... if he wants to do so.

And I'm anxious to get back to the Grannymede as quickly as possible. Falcon's a fine little spacecraft, but her plumbing could be improved - it's beginning to smell in here, and I'm itching for a shower.

Look forward to seeing you - and especially Ted Khan.

We have much to talk about, before I return to Earth.

TRANSMIT

STORE



TERMINATION

*The toil of all that be
Heals not the primal fault;
It rains into the sea,
And still the sea is salt.*

- A. E. Housman, More Poems

32

A Gentleman of Leisure

On the whole, it had been an interesting but uneventful decades, punctuated by the joys and sorrows which Time and Fate bring to all mankind. The greatest of those had been wholly unexpected; in fact, before he left for Ganymede, Poole would have dismissed the very idea as preposterous.

There is much truth in the saying that absence makes the heart grow fonder. When he and Indra Wallace met again, they discovered that, despite their bantering and occasional disagreements, they were closer than they had imagined. One thing led to another including, to their mutual joy, Dawn Wallace and Martin Poole.

It was rather late in life to start a family - quite apart from that little matter of a thousand years - and Professor Anderson had warned them that it might be impossible. Or even worse...

'You were lucky in more ways than you realize,' he told Poole. 'Radiation damage was surprisingly low, and we were able to make all essential repairs from your intact DNA. But until we do some more tests, I

can't promise genetic integrity. So enjoy yourselves - but don't start a family until I give the OK.'

The tests had been time-consuming, and as Anderson had feared, further repairs were necessary. There was one major set-back - something that could never have lived, even if it had been allowed to go beyond the first few weeks after conception - but Martin and Dawn were perfect, with just the right number of heads, arms and legs. They were also handsome and intelligent, and barely managed to escape being spoiled by their doting parents - who continued to be the best of friends when, after fifteen years, each opted for independence again. Because of their Social Achievement Rating, they would have been permitted - indeed, encouraged - to have another child, but they decided not to put any more of a burden on their astonishingly good luck.

One tragedy had shadowed Poole's personal life during this period - and indeed had shocked the whole Solar community. Captain Chandler and his entire crew had been lost when the nucleus of a comet they were reconnoitring exploded suddenly, destroying Goliath so completely that only a few fragments were ever located. Such explosions - caused by reactions among unstable molecules which existed at very low temperatures - were a well-known danger to comet-collectors, and Chandler had encountered several during his career. No one would ever know the exact circumstances which caused so experienced a spaceman to be taken by surprise.

Poole missed Chandler very badly: he had played a unique role in his life, and there was no one to replace him - no one, except Dave Bowman, with whom he had shared so momentous an adventure. He and Chandler had often made plans to go into space together again, perhaps all the way out to the Oort Cloud with its unknown mysteries and its remote but inexhaustible wealth of ice. Yet some conflict of schedules had always upset their plans, so this was a wished-for future that would never exist.

Another long-desired goal Poole had managed to achieve - despite doctor's orders. He had been down to Earth: and once was quite enough.

The vehicle in which he had travelled looked almost identical to the wheelchairs used by the luckier paraplegics of his own time. It was motorized, and had balloon tyres which allowed it to roll over reasonably smooth surfaces. However, it could also fly - at an altitude of about twenty centimetres - on an aircushion produced by a set of small but very powerful fans. Poole was surprised that so primitive a technology was still in use, but inertia-control devices were too bulky for such small-scale applications.

Seated comfortably in his hoverchair, he was scarcely conscious of his increasing weight as he descended into the heart of Africa; though he did notice some difficulty in breathing, he had experienced far worse during his astronaut training. What he was not prepared for was the blast of furnace-heat that smote him as he rolled out of the gigantic, sky-piercing cylinder that formed the base of the Tower. Yet it was still morning: what would it be like at noon?

He had barely accustomed himself to the heat when his sense of smell was assailed. A myriad odours - none unpleasant, but all unfamiliar - clamoured for his attention. He closed his eyes for a few minutes, in an attempt to avoid overloading his input circuits.

Before he had decided to open them again, he felt some large, moist object palpating the back of his neck.

'Say hello to Elizabeth,' said his guide, a burly young man dressed in traditional Great White Hunter garb, much too smart to have seen any real use: 'she's our official greeter.'

Poole twisted round in his chair, and found himself looking into the soulful eyes of a baby elephant.

'Hello, Elizabeth,' he answered, rather feebly. Elizabeth lifted her trunk in salute, and emitted a sound not usually heard in polite society, though Poole felt sure it was well-intentioned.

Altogether, he spent less than an hour on Planet Earth, skirting the edge of a jungle whose stunted trees compared unfavourably with Skyland's, and encountering much of the local fauna. His guides apologized for the friendliness of the lions, who had been spoilt by tourists - but the malevolent expressions of the crocodiles more than compensated; here was Nature raw and unchanged.

Before he returned to the Tower, Poole risked taking a few steps away from his hoverchair. He realized that this would be the equivalent of carrying his own weight on his back, but that did not seem an impossible feat, and he would never forgive himself unless he attempted it.

It was not a good idea; perhaps he should have tried it in a cooler climate. After no more than a dozen steps, he was glad to sink back into the luxurious clutches of the chair.

'That's enough,' he said wearily. 'Let's go back to the Tower.'

As he rolled into the elevator lobby, he noticed a sign which he had somehow overlooked during the excitement of his arrival. It read:

WELCOME TO AFRICA!

'In wildness is the preservation of the world.'

HENRY DAVID THOREAU

(1817-1862)

Observing Poole's interest, the guide asked 'Did you know him?'

It was the sort of question Poole heard all too often, and at the moment he did not feel equipped to deal with it.

'I don't think so,' he answered wearily, as the great doors closed behind them, shutting out the sights, scents and sounds of Mankind's earliest home.

His vertical safari had satisfied his need to visit Earth, and he did his best to ignore the various aches and pains acquired there when he returned to his apartment at Level 10,000 - a prestigious location, even in this democratic society. Indra, however, was mildly shocked by his appearance, and ordered him straight to bed.

'Just like Antaeus - but in reverse!' she muttered darkly. 'Who?' asked Poole: there were times when his wife's erudition was a little overwhelming, but he had determined never to let it give him an inferiority complex.

'Son of the Earth Goddess, Gaea. Hercules wrestled with him - but every time he was thrown to the ground, Antaeus renewed his strength.'

'Who won?'

'Hercules, of course - by holding Antaeus in the air, so Ma couldn't recharge his batteries.'

'Well, I'm sure it won't take me long to recharge mine. And I've learned one lesson. If I don't get more exercise, I may have to move up to Lunar Gravity level.'

Poole's good resolution lasted a full month: every morning he went for a brisk five-kilometre walk, choosing a different level of the Africa Tower each day. Some floors were still vast, echoing deserts of metal which would probably never be occupied, but others had been landscaped and

developed over the centuries in a bewildering variety of architectural styles. Many were borrowings from past ages and cultures; others hinted at futures which Poole would not care to visit. At least there was no danger of boredom, and on many of his walks he was accompanied, at a respectful distance, by small groups of friendly children. They were seldom able to keep up with him for long.

One day, as Poole was striding down a convincing - though sparsely populated - imitation of the Champs Elyse'es, he suddenly spotted a familiar face.

'Danil!' he called.

The other man took not the slightest notice, even when Poole called again, more loudly.

'Don't you remember me?'

Danil - and now that he had caught up with him, Poole did not have the slightest doubt of his identity - looked genuinely baffled.

'I'm sorry,' he said. 'You're Commander Poole, of course. But I'm sure we've never met before.'

Now it was Poole's turn to be embarrassed.

'Stupid of me,' he apologized. 'Must have mistaken you for someone else. Have a good day.'

He was glad of the encounter, and was pleased to know that Danil was back in normal society. Whether his original crime had been axe-murders or overdue library books should no longer be the concern of his one-time employer; the account had been settled, the books closed. Although Poole sometimes missed the cops-and-robbers dramas he had often enjoyed in

his youth, he had grown to accept the current wisdom: excessive interest in pathological behaviour was itself pathological.

With the help of Miss Pringle, Mk III, Poole had been able to schedule his life so that there were even occasional blank moments when he could relax and set his Braincap on Random Search, scanning his areas of interest. Outside his immediate family, his chief concerns were still among the moons of Jupiter/Lucifer, not least because he was recognized as the leading expert on the subject, and a permanent member of the Europa Committee.

This had been set up almost a thousand years ago, to consider what, if anything, could and should be done about the mysterious satellite. Over the centuries, it had accumulated a vast amount of information, going all the way back to the Voyager flybys of 1979 and the first detailed surveys from the orbiting Galileo spacecraft of 1996.

Like most long-lived organizations, the Europa Committee had become slowly fossilized, and now met only when there was some new development. It had woken up with a start after Halman's reappearance, and appointed an energetic new chairperson whose first act had been to co-opt Poole.

Though there was little that he could contribute that was not already recorded, Poole was very happy to be on the Committee. It was obviously his duty to make himself available, and it also gave him an official position he would otherwise have lacked. Previously his status was what had once been called a 'national treasure', which he found faintly embarrassing. Although he was glad to be supported in luxury by a world wealthier than all the dreams of war-ravaged earlier ages could have imagined, he felt the need to justify his existence.

He also felt another need, which he seldom articulated even to himself. Halman had spoken to him, if only briefly, at their strange encounter two decades ago. Poole was certain that, if he wished, Halman could easily do

so again. Were all human contacts no longer of interest to him? He hoped that was not the case; yet that might be one explanation of his silence.

He was frequently in touch with Theodore Khan - as active and acerbic as ever, and now the Europa Committee's representative on Ganymede. Ever since Poole had returned to Earth, Ted had been trying in vain to open a channel of communication with Bowman. He could not understand why long lists of important questions on subjects of vital philosophical and historic interest received not even brief acknowledgements.

'Does the Monolith keep your friend Halman so busy that he can't talk to me?' he complained to Poole. 'What does he do with his time, anyway?'

It was a very reasonable question; and the answer came, like a thunderbolt out of a cloudless sky, from Bowman himself - as a perfectly commonplace vidphone call.

33

Contact

'Hello, Frank. This is Dave. I have a very important message for you. I assume that you are now in your suite in Africa Tower. If you are there, please identify yourself by giving the name of our instructor in orbital mechanics. I will wait for sixty seconds, and if there is no reply will try again in exactly one hour.'

That minute was hardly long enough for Poole to recover from the shock. He felt a brief surge of delight, as well as astonishment, before another emotion took over. Glad though he was to hear from Bowman again, that phrase 'a very important message' sounded distinctly ominous.

At least it was fortunate, Poole told himself, that he's asked for one of the few names I can remember. Yet who could forget a Scot with a Glasgow accent so thick it had taken them a week to master it? But he had been a brilliant lecturer - once you understood what he was saying.

'Dr Gregory McVitty.'

'Accepted. Now please switch on your Braincap receiver. It will take three minutes to download this message. Do not attempt to monitor: I am using ten-to-one compression. I will wait two minutes before starting.'

How is he managing to do this? Poole wondered. Jupiter/Lucifer was now over fifty light-minutes away, so this message must have left almost an hour ago. It must have been sent with an intelligent agent in a properly addressed package on the Ganymede-Earth beam - but that would have been a trivial feat to Halman, with the resources he had apparently been able to tap inside the Monolith.

The indicator light on the Brainbox was flickering. The message was coming through.

At the compression Halman was using, it would take half an hour for Poole to absorb the message in real-time. But he needed only ten minutes to know that his peaceful life-style had come to an abrupt end

34

Judgement

In a world of universal and instantaneous communication, it was very difficult to keep secrets. This was a matter, Poole decided immediately, for face-to-face discussion.

The Europa Committee had grumbled, but all its members had assembled in his apartment. There were seven of them - the lucky number, doubtless suggested by the phases of the Moon, that had always fascinated Mankind. It was the first time Poole had met three of the Committee's members, though by now he knew them all more thoroughly than he could possibly have done in a pre-Braincapped lifetime.

'Chairperson Oconnor, members of the Committee - I'd like to say a few words - only a few, I promise! - before you download the message I've received from Europa. And this is something I prefer to do verbally; that's more natural for me - I'm afraid I'll never be quite at ease with direct mental transfer.'

'As you all know, Dave Bowman and Hal have been stored as emulations in the Monolith on Europa. Apparently it never discards a tool it once found useful, and from time to time it activates Halman, to monitor our affairs - when they begin to concern it. As I suspect my arrival may have done - though perhaps I flatter myself.'

'But Halman isn't just a passive tool. The Dave component still retains something of its human origins - even emotions. And because we were trained together - shared almost everything for years - he apparently finds it much easier to communicate with me than with anyone else. I would like to think he enjoys doing it, but perhaps that's too strong a word.'

'He's also curious - inquisitive - and perhaps a little resentful of the way he's been collected, like a specimen of wildlife. Though that's probably what we are, from the viewpoint of the intelligence that created the Monolith.'

'And where is that intelligence now? Halman apparently knows the answer, and it's a chilling one.'

'As we always suspected, the Monolith is part of a galactic network of some kind. And the nearest node - the Monolith's controller, or immediate superior - is 450 light-years away.'

'Much too close for comfort! This means that the report on us and our affairs that was transmitted early in the twenty-first century was received half a millennium ago. If the Monolith's - let's say Supervisor - replied at once, any further instructions should be arriving just about now.'

'And that's exactly what seems to be happening. During the last few days, the Monolith has been receiving a continuous string of messages, and has been setting up new programs, presumably in accordance with these.'

'Unfortunately, Halman can only make guesses about the nature of those instructions. As you'll gather when you've downloaded this tablet, he has some limited access to many of the Monolith's circuits and memory banks, and can even carry on a kind of dialogue with it. If that's the right word - since you need two people for that! I still can't really grasp the idea that the Monolith, for all its powers, doesn't possess consciousness - doesn't even know that it exists!'

'Halman's been brooding over the problem for a thousand years - on and off - and has come to the same answer that most of us have done. But his conclusion must surely carry far more weight, because of his inside knowledge.'

'Sorry! I wasn't intending to make a joke - but what else could you call it?'

'Whatever went to the trouble of creating us - or at least tinkering with our ancestors' minds and genes - is deciding what to do next. And Halman is pessimistic. No - that's an exaggeration. Let's say he doesn't think much of our chances, but is now too detached an observer to be unduly worried.'

The future - the survival! - of the human race isn't much more than an interesting problem to him, but he's willing to help.'

Poole suddenly stopped talking, to the surprise of his intent audience.

'That's strange. I've just had an amazing flashback... I'm sure it explains what's happening. Please bear with me.'

'Dave and I were walking together one day, along the beach at the Cape, a few weeks before launch, when we noticed a large beetle lying on the sand. As often happens, it had fallen on its back and was waving its legs in the air, struggling to get right-way-up.'

'I ignored it - we were engaged in some complicated technical discussion - but not Dave. He stepped aside, and carefully flipped it over with his shoe. As it flew away I commented, "Are you sure that was a good idea? Now it will go off and chomp somebody's prize chrysanthemums." And he answered, "Maybe you're right. But I'd like to give it the benefit of the doubt."

'My apologies - I'd promised to say only a few words! But I'm very glad I remembered that incident: I really believe it puts Halman's message in the right perspective. He's giving the human race the benefit of the doubt...'

'Now please check your Braincaps. This is a high-density recording - top of the u.v. band, Channel 110. Make yourselves comfortable, but be sure you're free line of sight. Here we go...'

No one asked for a replay. Once was sufficient.

There was a brief silence when the playback finished; then Chairperson Dr Oconnor removed her Braincap, massaged her shining scalp, and said slowly:

'You taught me a phrase from your period that seems very appropriate now. This is a can of worms.'

'But only Bowman - Halman - has opened it,' said one of the Committee members. 'Does he really understand the operation of something as complex as the Monolith? Or is this whole scenario a figment of his imagination?'

'I don't think he has much imagination,' Dr Oconnor answered. 'And everything checks perfectly. Especially the reference to Nova Scorpio. We assumed that was an accident; apparently it was a - judgement.'

'First Jupiter - now Scorpio,' said Dr Kraussman, the distinguished physicist who was popularly regarded as a reincarnation of the legendary Einstein. A little plastic surgery, it was rumoured, had also helped. 'Who will be next in line?'

'We always guessed,' said the Chair, 'that the TMAs were monitoring us.' She paused for a moment, then added ruefully: 'What bad - what incredibly bad! - luck that the final report went off, just after the very worst period in human history!'

There was another silence. Everyone knew that the twentieth century had often been branded 'The Century of Torture'

Poole listened without interrupting, while he waited for some consensus to emerge. Not for the first time, he was impressed by the quality of the Committee. No one was trying to prove a pet theory, score debating points, or inflate an ego: he could not help drawing a contrast with the often bad-tempered arguments he had heard in own time, between Space Agency engineers and administrators, Congressional staffs, and industrial executives.

Yes, the human race had undoubtedly improved. The Braincap had not only helped to weed out misfits, but had enormously increased the efficiency of education. Yet there had also been a loss; there were very few memorable characters in this society. Offhand he could think of only four - Indra, Captain Chandler, Dr Khan and the Dragon Lady of wistful memory.

The Chairperson let the discussion flow smoothly back and forth until everyone had had a say, then began her summing up.

'The obvious first question - how seriously should we take this threat - isn't worth wasting time on. Even if it's a false alarm, or a misunderstanding, it's potentially so grave that we must assume it's real, until we have absolute proof to the contrary. Agreed?'

'Good. And we don't know how much time we have. So we must assume that the danger is immediate. Perhaps Halman may be able to give us some further warning, but by then it may be too late.'

'So the only thing we have to decide is: how can we protect ourselves, against something as powerful as the Monolith? Look what happened to Jupiter! And, apparently, Nova Scorpio...'

'I'm sure that brute force would be useless, though perhaps we should explore that option. Dr Kraussman - how long would it take to build a super-bomb?'

'Assuming that the designs still exist, so that no research is necessary - oh, perhaps two weeks. Thermonuclear weapons are rather simple, and use common materials - after all, they made them back in the Second Millennium! But if you wanted something sophisticated - say an antimatter bomb, or a mini-black-hole - well, that might take a few months.'

'Thank you: could you start looking into it? But as I've said, I don't believe it would work; surely something that can handle such powers must also be able to protect itself against them. So - any other suggestions?'

'Can we negotiate?' one councillor asked, not very hopefully.

'With what... or whom?' Kraussman answered. 'As we've discovered, the Monolith is essentially a pure mechanism, doing just what it's been programmed to do. Perhaps that program is flexible enough to allow of changes, but there's no way we can tell. And we certainly can't appeal to Head Office - that's half a thousand light-years away!'

Poole listened without interrupting; there was nothing he could contribute to the discussion, and indeed much of it was completely over his head. He began to feel an insidious sense of depression, would it have been better, he wondered, not to pass on this information? Then, if it was a false alarm, no one would be any the worse. And if it was not - well, humanity would still have peace of mind, before whatever inescapable doom awaited it.

He was still mulling over these gloomy thoughts when he was suddenly alerted by a familiar phrase.

A quiet little member of the Committee, with a name so long and difficult that Poole had never been able to remember, still less pronounce it, had abruptly dropped just two words into the discussion.

'Trojan Horse!'

There was one of those silences generally described as 'pregnant', then a chorus of 'Why didn't I think of that!' 'Of course!' 'Very good idea!' until the Chairperson, for the first time in the session, had to call for order.

'Thank you, Professor Thirugnanasampanthamoorthy,' said Dr Oconnor, without missing a beat. 'Would you like to be more specific?'

'Certainly. If the Monolith is indeed, as everyone seems to think, essentially a machine without consciousness - and hence with only limited self-monitoring ability - we may already have the weapons that can defeat it. Locked up in the Vault.'

'And a delivery system - Halman!'

'Precisely.'

'Just a minute, Dr T. We know nothing - absolutely nothing - about the Monolith's architecture. How can we be sure that anything our primitive species ever designed would be effective against it?'

'We can't - but remember this. However sophisticated it is, the Monolith has to obey exactly the same universal laws of logic that Aristotle and Boole formulated, centuries ago. That's why it may - no, should! - be vulnerable to the things locked up in the Vault. We have to assemble them in such a way that at least one of them will work. It's our only hope - unless anybody can suggest a better alternative.'

'Excuse me,' said Poole, finally losing patience. 'Will someone kindly tell me - what and where is this famous Vault you're talking about?'

History is full of nightmares, some natural, some manmade.

By the end of the twenty-first century, most of the natural ones - smallpox, the Black Death, AIDS, the hideous viruses lurking in the African jungle - had been eliminated, or at least brought under control, by the advance of medicine. However, it was never wise to underestimate the ingenuity of Mother Nature, and no one doubted that the future would still have unpleasant biological surprises in store for Mankind.

It seemed a sensible precaution, therefore, to keep a few specimens of all these horrors for scientific study - carefully guarded, of course, so that there was no possibility of them escaping and again wreaking havoc on the human race. But how could one be absolutely sure that there was no danger of this happening?

There had been - understandably - quite an outcry in the late twentieth century when it was proposed to keep the last known smallpox viruses at Disease Control Centres in the United States and Russia. However unlikely it might be, there was a finite possibility that they might be released by such accidents as earthquakes, equipment failures - or even deliberate sabotage by terrorist groups.

A solution that satisfied everyone (except a few 'Preserve the lunar wilderness!' extremists) was to ship them to the Moon, and to keep them in a laboratory at the end of a kilometre-long shaft drilled into the isolated mountain Pico, one of the most prominent features of the Mare Imbrium.

And here, over the years, they were joined by some of the most outstanding examples of misplaced human ingenuity - indeed, insanity.

There were gases and mists that, even in microscopic doses, caused slow or instant death. Some had been created by religious cultists who, though mentally deranged, had managed to acquire considerable scientific knowledge. Many of them believed that the end of the world was at hand (when, of course, only their followers would be saved). In case God was absent-minded enough not to perform as scheduled, they wanted to make sure that they could rectify His unfortunate oversight.

The first assaults of these lethal cultists were made on such vulnerable targets as crowded subways, World Fairs, sports stadiums, pop concerts... tens of thousands were killed, and many more injured before the madness was brought under control in the early twenty-first century. As often happens, some good came out of evil, because it forced the world's law-enforcement agencies to co-operate as never before; even rogue states which had promoted political terrorism were unable to tolerate this random and wholly unpredictable variety.

The chemical and biological agents used in these attacks - as well as in earlier forms of warfare - joined the deadly collection in Pico. Their antidotes, when they existed, were also stored with them. It was hoped that none of this material would ever concern humanity again - but it was still available, under heavy guard, if it was needed in some desperate emergency.

The third category of items stored in the Pico vault, although they could be classified as plagues, had never killed or injured anyone - directly. They had not even existed before the late twentieth century, but in a few decades they had done billions of dollars' worth of damage, and often wrecked lives as effectively as any bodily illness could have done. They were the diseases which attacked Mankind's newest and most versatile servant, the computer.

Taking names from the medical dictionaries - viruses, prions, tapeworms - they were programs that often mimicked, with uncanny accuracy, the behaviour of their organic relatives. Some were harmless - little more than playful jokes, contrived to surprise or amuse Computer operators by unexpected messages and images on their visual displays. Others were far more malicious - deliberately designed agents of catastrophe.

In most cases their purpose was entirely mercenary; they were the weapons that sophisticated criminals used to blackmail the banks and commercial organizations that now depended utterly upon the efficient operation of their computer systems. On being warned that their data banks would be erased automatically at a certain time, unless they transferred a few megadollars to some anonymous offshore number, most victims decided not to risk possibly irreparable disaster. They paid up quietly, often - to avoid public or even private embarrassment - without notifying the police.

This understandable desire for privacy made it easy for the network highwaymen to conduct their electronic holdups: even when they were caught, they were treated gently by legal systems which did not know how to handle such novel crimes - and, after all, they had not really hurt anyone, had they? Indeed, after they had served their brief sentences, many of the perpetrators were quietly hired by their victims, on the old principle that poachers make the best game-keepers.

These computer criminals were driven purely by greed, and certainly did not wish to destroy the organizations they preyed upon: no sensible parasite kills its host. But there were other, and much more dangerous, enemies of society at work...

Usually, they were maladjusted individuals - typically adolescent males - working entirely alone, and of course in complete secrecy. Their aim was to create programs which would simply create havoc and confusion, when they had been spread over the planet by the world-wide cable and radio

networks, or on physical carriers such as diskettes and CD ROMS. Then they would enjoy the resulting chaos, basking in the sense of power it gave their pitiful psyches.

Sometimes, these perverted geniuses were discovered and adopted by national intelligence agencies for their own secretive purposes - usually, to break into the data banks of their rivals. This was a fairly harmless line of employment, as the organizations concerned did at least have some sense of civic responsibility.

Not so the apocalyptic sects, who were delighted to discover this new armoury, holding weapons far more effective, and more easily disseminated, than gas or germs. And much more difficult to counter, since they could be broadcast instantaneously to millions of offices and homes.

The collapse of the New York-Havana Bank in 2005, the launching of Indian nuclear missiles in 2007 (luckily with their warheads unactivated), the shutdown of Pan-European Air Traffic Control in 2008, the paralysis of the North American telephone network in that same year - all these were cult-inspired rehearsals for Doomsday. Thanks to brilliant feats of counterintelligence by normally uncooperative, and even warring, national agencies, this menace was slowly brought under control.

At least, so it was generally believed: there had been no serious attacks at the very foundations of society for several hundred years. One of the chief weapons of victory had been the Braincap - though there were some who believed that this achievement had been bought at too great a cost.

Though arguments over the freedom of the Individual versus the duties of the State were old when Plato and Aristotle attempted to codify them, and would probably continue until the end of time, some consensus had been reached in the Third Millennium. It was generally agreed that Communism was the most perfect form of government; unfortunately it had been demonstrated - at the cost of some hundreds of millions of lives -

that it was only applicable to social insects, Robots Class II, and similar restricted categories. For imperfect human beings, the least-worst answer was Demosocracy, frequently defined as 'individual greed, moderated by an efficient but not too zealous government'.

Soon after the Braincap came into general use, some highly intelligent - and maximally zealous - bureaucrats realized that it had a unique potential as an early-warning system. During the setting-up process, when the new wearer was being mentally 'calibrated' it was possible to detect many forms of psychosis before they had a chance of becoming dangerous. Often this suggested the best therapy, but when no cure appeared possible the subject could be electronically tagged - or, in extreme cases, segregated from society. Of course, this mental monitoring could test only those who were fitted with a Braincap - but by the end of the Third Millennium this was as essential for everyday life as the personal telephone had been at its beginning. In fact, anyone who did not join the vast majority was automatically suspect, and checked as a potential deviant.

Needless to say, when 'mind-probing', as its critics called it, started coming into general use, there were cries of outrage from civil-rights organizations; one of their most effective slogans was 'Braincap or Braincop?' Slowly - even reluctantly - it was accepted that this form of monitoring was a necessary precaution against far worse evils; and it was no coincidence that with the general improvement in mental health, religious fanaticism also started its rapid decline-

When the long-drawn-out war against the cybernet criminals ended, the victors found themselves owning an embarrassing collection of spoils, all of them utterly incomprehensible to any past conqueror. There were, of course, hundreds of computer viruses, most of them very difficult to detect and kill. And there were some entities - for want of a better name - that were much more terrifying. They were brilliantly invented diseases for which there was no cure - in some cases not even the possibility of a cure

Many of them had been linked to great mathematicians who would have been horrified by this corruption of their discoveries. As it is a human characteristic to belittle a real danger by giving it an absurd name, the designations were often facetious: the Godel Gremlin, the Mandelbrot Maze, the Combinatorial Catastrophe, the Transfinite Trap, the Conway Conundrum, the Turing Torpedo, the Lorentz Labyrinth, the Boolean Bomb, the Shannon Snare, the Cantor Cataclysm...

If any generalization was possible, all these mathematical horrors operated on the same principle. They did not depend for their effectiveness on anything as naïve as memory-erasure or code corruption - on the contrary. Their approach was more subtle; they persuaded their host machine to initiate a program which could not be completed before the end of the universe, or which - the Mandelbrot Maze was the deadliest example - involved a literally infinite series of steps.

A trivial example would be the calculation of Pi, or any other irrational number. However, even the most stupid electro-optic computer would not fall into such a simple trap: the day had long since passed when mechanical morons would wear out their gears, grinding them to powder as they tried to divide by zero...

The challenge to the demon programmers was to convince their targets that the task set them had a definite conclusion that could be reached in a finite time. In the battle of wits between man (seldom woman, despite such role-models as Lady Ada Lovelace, Admiral Grace Hopper and Dr Susan Calvin) and machine, the machine almost invariably lost.

It would have been possible - though in some cases difficult and even risky - to destroy the captured obscenities by ERASE/OVERWRITE commands, but they represented an enormous investment in time and ingenuity which, however misguided, seemed a pity to waste. And, more important, perhaps they should be kept for study, in some secure location, as a safeguard against the time when some evil genius might reinvent and deploy them.

The solution was obvious. The digital demons should be sealed with their chemical and biological counterparts, it was hoped for ever, in the Pico Vault.

37

Operation Damocles

Poole never had much contact with the team who assembled the weapon everyone hoped would never have to be used. The operation - ominously, but aptly, named Damocles - was so highly specialized that he could contribute nothing directly, and he saw enough of the task force to realize that some of them might almost belong to an alien species. Indeed, one key member was apparently in a lunatic asylum - Poole had been surprised to find that such places still existed - and Chairperson Oconnor sometimes suggested that at least two others should join him.

'Have you ever heard of the Enigma Project?' she remarked to Poole, after a particularly frustrating session. When he shook his head, she continued: 'I'm surprised - it was only a few decades before you were born: I came across it while when I was researching material for Damocles. Very similar problem - in one of your wars, a group of brilliant mathematicians was gathered together, in great secrecy, to break an enemy code... incidentally, they built one of the very first real computers, to make the job possible.'

'And there's a lovely story - I hope it's true - that reminds me of our own little team. One day the Prime Minister came on a visit of inspection, and afterwards he said to Enigma's Director: "When I told you to leave no stone unturned to get the men you needed, I didn't expect you to take me so literally".'

Presumably all the right stones had been turned for Project Damocles. However, as no one knew whether they were working against a deadline of days, weeks or years, at first it was hard to generate any sense of urgency. The need for secrecy also created problems; since there was no point in spreading alarm throughout the Solar System, not more than fifty people knew of the project. But they were the people who mattered - who could marshal all the forces necessary, and who alone could authorize the opening of the Pico Vault, for the first time in five hundred years.

When Halman reported that the Monolith was receiving messages with increasing frequency, there seemed little doubt that something was going to happen. Poole was not the only one who found it hard to sleep in those days, even with the help of the Braincap's anti-insomnia programs. Before he finally did get to sleep, he often wondered if he would wake up again. But at last all the components of the weapon were assembled - a weapon invisible, untouchable and unimaginable to almost all the warriors who had ever lived.

Nothing could have looked more harmless and innocent than the perfectly standard terabyte memory tablet, used with millions of Braincaps every day. But the fact that it was encased in a massive block of crystalline material, criss-crossed with metal bands, indicated that it was something quite out of the ordinary. Poole received it with reluctance; he wondered if the courier who had been given the awesome task of carrying the Hiroshima atom bomb's core to the Pacific airbase from which it was launched had felt the same way. And yet, if all their fears were justified, his responsibility might be even greater.

And he could not be certain that even the first part of his mission would be successful. Because no circuit could be absolutely secure, Halman had not yet been informed about Project Damocles; Poole would do that when he returned to Ganymede.

Then he could only hope that Halman would be willing to play the role of Trojan Horse - and, perhaps, be destroyed in the process.

38

Pre-emptive Strike

It was strange to be back in the Hotel Grannymede after all these years - strangest of all, because it seemed completely unchanged, despite everything that had happened. Poole was still greeted by the familiar image of Bowman as he walked into the suite named after him: and, as he expected, Bowman/Halman was waiting, looking slightly less substantial than the ancient hologram.

Before they could even exchange greetings, there was an interruption that Poole would have welcomed - at any other time than this. The room vidphone gave its urgent trio of rising notes - also unchanged since his last visit -and an old friend appeared on the screen.

'Frank!' cried Theodore Khan, 'why didn't you tell me you were coming! When can we meet? Why no video - someone with you? And who were all those official-looking types who landed at the same time -'

'Please Ted! Yes, I'm sorry - but believe me, I've got very good reasons - I'll explain later. And I do have someone with me - call you back just as soon as I can. Good-bye!'

As he belatedly gave the 'Do Not Disturb' order, Poole said apologetically: 'Sorry about that - you know who it was, of course.'

'Yes - Dr Khan. He often tried to get in touch with me.'

'But you never answered. May I ask why?' Though there were far more important matters to worry about, Poole could not resist putting the question.

'Ours was the only channel I wished to keep open. Also, I was often away. Sometimes for years.'

That was surprising - yet it should not have been. Poole knew well enough that Halman had been reported in many places, in many times. Yet - 'away for years'? He might have visited quite a few star systems - perhaps that was how he knew about Nova Scorpio, only forty light-years distant. But he could never have gone all the way to the Node; there and back would have been a nine-hundred-year journey.

'How lucky that you were here when we needed you!' It was very unusual for Halman to hesitate before replying. There was much longer than the unavoidable three-second time-lag before he said slowly 'Are you sure that it was luck?'

'What do you mean?'

'I do not wish to talk about it, but twice I have - glimpsed - powers - entities - far superior to the Monoliths, and perhaps even their makers. We may both have less freedom than we imagine.'

That was indeed a chilling thought; Poole needed a deliberate effort of will to put it aside and concentrate on the immediate problem.

'Let us hope we have enough free-will to do what is necessary. Perhaps this is a foolish question. Does the Monolith know that we are meeting? Could it be - suspicious?'

'It is not capable of such an emotion. It has numerous fault-protection devices, some of which I understand. But that is all.'

'Could it be overhearing us now?'

'I do not believe so.'

I wish that I could be sure it was such a naïve and simple-minded super-genius, thought Poole as he unlocked his briefcase and took out the sealed box containing the tablet. In this low gravity its weight was almost negligible; it was impossible to believe that it might hold the destiny of Mankind.

'There was no way we could be certain of getting a secure circuit to you, so we couldn't go into details. This tablet contains programs which we hope will prevent the Monolith from carrying out any orders which threaten Mankind. There are twenty of the most devastating viruses ever designed on this, most of which have no known antidote; in some cases, it is believed that none is possible. There are five copies of each. We would like you to release them when - and if - you think it is necessary. Dave - Hal - no one has ever been given such a responsibility. But we have no other choice.'

Once again, the reply seemed to take longer than the three-second round trip from Europa.

'If we do this, all the Monolith's functions may cease. We are uncertain what will happen to us then.'

'We have considered that, of course. But by this time, you must surely have many facilities at your command -some of them probably beyond our understanding. I am also sending you a petabyte memory tablet. Ten to the fifteenth bytes is more than sufficient to hold all the memories and experiences of many lifetimes. This will give you one escape route: I suspect you have others.'

'Correct. We will decide which to use at the appropriate time.'

Poole relaxed - as far as was possible in this extraordinary situation. Halman was willing to co-operate: he still had sufficient links with his origins.

'Now, we have to get this tablet to you - physically. Its contents are too dangerous to risk sending over any radio or optical channel. I know you possess long-range control of matter: did you not once detonate an orbiting bomb? Could you transport it to Europa? Alternatively, we could send it in an auto-courier, to any point you specify.'

'That would be best: I will collect it in Tsienville. Here are the coordinates...

Poole was still slumped in his chair when the Bowman Suite monitor admitted the head of the delegation that had accompanied him from Earth. Whether Colonel Jones was a genuine Colonel - or even if his name was Jones - were minor mysteries which Poole was not really interested in solving; it was sufficient that he was a superb organizer and had handled the mechanics of Operation Damocles with quiet efficiency.

'Well, Frank - it's on its way. Will be landing in one hour, ten minutes. I assume that Halman can take it from there, but I don't understand how he can actually handle - is that the right word? - these tablets.'

'I wondered about that, until someone on the Europa Committee explained it. There's a well-known - though not to me! - theorem stating that any computer can emulate any other computer. So I'm sure that Halman knows exactly what he's doing. He would never have agreed otherwise.'

'I hope you're right,' replied the Colonel. 'If not - well, I don't know what alternative we have.'

There was a gloomy pause, until Poole did his best to relieve the tension.

'By the way, have you heard the local rumour about our visit?'

'Which particular one?'

'That we're a special commission sent here to investigate crime and corruption in this raw frontier township. The Mayor and the Sheriff are supposed to be running scared.'

'How I envy them,' said 'Colonel Jones'. 'Sometimes it's quite a relief to have something trivial to worry about.'

39

Deicide

Like all the inhabitants of Anubis City (population now 56,521), Dr Theodore Khan woke soon after local midnight to the sound of the General Alarm. His first reaction was 'Not another Icequake, for Deus's sake!'

He rushed to the window, shouting 'Open' so loudly that the room did not understand, and he had to repeat the order in a normal voice. The light of Lucifer should have come streaming in, painting the patterns on the floor that so fascinated visitors from Earth, because they never moved even a fraction of a millimetre, no matter how long they waited...

That unvarying beam of light was no longer there. As Khan stared in utter disbelief through the huge, transparent bubble of the Anubis Dome,

he saw a sky that Ganymede had not known for a thousand years. It was once more ablaze with stars; Lucifer had gone.

And then, as he explored the forgotten constellations, Kahn noticed something even more terrifying. Where Lucifer should have been was a tiny disc of absolute blackness, eclipsing the unfamiliar stars.

There was only one possible explanation, Khan told himself numbly. Lucifer has been swallowed by a Black Hole. And it may be our turn next.

On the balcony of the Grannymede Hotel, Poole was watching the same spectacle, but with more complex emotions. Even before the general alarm, his comsec had woken him with a message from Halman.

'It is beginning. We have infected the Monolith. But one - perhaps several - of the viruses have entered our own circuits. We do not know if we will be able to use the memory tablet you have given us. If we succeed, we will meet you in Tsienville.'

Then came the surprising and strangely moving words whose exact emotional content would be debated for generations:

'If we are unable to download, remember us.' From the room behind him, Poole heard the voice of the Mayor, doing his best to reassure the now sleepless citizens of Anubis. Though he opened with that most terrifying of official statements - 'No cause for alarm' - the Mayor did indeed have words of comfort.

'We don't know what's happening but Lucifer's still shining normally! I repeat - Lucifer is still shining! We've just received news from the interorbit shuttle Alcyone, which left for Callisto half an hour ago. Here's their view -', Poole left the balcony and rushed into his room just in time to see Lucifer blaze reassuringly on the vidscreen.

'What's happened,' the Mayor continued breathlessly, 'is that something has caused a temporary eclipse - we'll zoom in to look at it... Callisto Observatory, come in please...'

How does he know it's 'temporary'? thought Poole, as he waited for the next image to come up on the screen.

Lucifer vanished, to be replaced by a field of stars. At the same time, the Mayor faded out and another voice took over:

'- two-metre telescope, but almost any instrument will do. It's a disc of perfectly black material, just over ten thousand kilometres across, so thin it shows no visible thickness. And it's placed exactly - obviously deliberately -to block Ganymede from receiving any light.

'We'll zoom in to see if it shows any details, though I rather doubt it...'

From the viewpoint of Callisto, the occulting disc was foreshortened into an oval, twice as long as it was wide. It expanded until it completely filled the screen; thereafter, it was impossible to tell whether the image was being zoomed, as it showed no structure whatsoever.

'As I thought - there's nothing to see. Let's pan over to the edge of the thing...'

Again there was no sense of motion, until a field of stars suddenly appeared, sharply defined by the curving edge of the world-sized disc. It was exactly as if they were looking past the horizon of an airless, perfectly smooth planet.

No, it was not perfectly smooth...

'That's interesting,' commented the astronomer, who until now had sounded remarkably matter-of-fact, as if this sort of thing was an everyday

occurrence. 'The edge looks jagged - but in a very regular fashion - like a saw-blade...'

A circular saw Poole muttered under his breath. Is it going to carve us up? Don't be ridiculous...

'This is as close as we can get before diffraction spoils the image - we'll process it later and get much better detail!'

The magnification was now so great that all trace of the disc's circularity had vanished. Across the vidscreen was a black band, serrated along its edge with triangles so identical that Poole found it hard to avoid the ominous analogy of a saw-blade. Yet something else was nagging at the back of his mind...

Like everyone else on Ganymede, he watched the infinitely more distant stars drifting in and out of those geometrically perfect valleys. Very probably, many others jumped to the same conclusion even before he did.

If you attempt to make a disc out of rectangular blocks -whether their proportions are 1:4:9 or any other - it cannot possibly have a smooth edge. Of course, you can make it as near a perfect circle as you like, by using smaller and smaller blocks. Yet why go to that trouble, if you merely wanted to build a screen large enough to eclipse a sun?

The Mayor was right; the eclipse was indeed temporary. But its ending was the precise opposite of a solar one.

First light broke through at the exact centre, not in the usual necklace of Bailey's Beads along the very edge. Jagged lines radiated from a dazzling pinhole - and now, under the highest magnification, the structure of the disc was being revealed. It was composed of millions of identical rectangles, perhaps the same size as the Great Wall of Europa. And now

they were splitting apart: it was as if a gigantic jigsaw puzzle was being dismantled.

Its perpetual, but now briefly interrupted, daylight was slowly returning to Ganymede, as the disc fragmented and the rays of Lucifer poured through the widening gaps. Now the components themselves were evaporating, almost as if they needed the reinforcement of each other's contact to maintain reality.

Although it seemed like hours to the anxious watchers in Anubis City, the whole event lasted for less than fifteen minutes. Not until it was all over did anyone pay attention to Europa itself.

The Great Wall was gone: and it was almost an hour before the news came from Earth, Mars and Moon that the Sun itself had appeared to flicker for a few seconds, before resuming business as usual.

It had been a highly selective set of eclipses, obviously targeted at humankind. Nowhere else in the Solar System would anything have been noticed.

In the general excitement, it was a little longer before the world realized that TMA ZERO and TMA ONE had both vanished, leaving only their four-million-year-old imprints on Tycho and Africa.

It was the first time the Europs could ever have met humans, but they seemed neither alarmed nor surprised by the huge creatures moving among them at such lightning speed. Of course, it was not too easy to interpret the emotional state of something that looked like a small, leafless bush, with no obvious sense organs or means of communication. But if they were frightened by the arrival of Alcyone, and the emergence of its passengers, they would surely have remained hiding in their igloos.

As Frank Poole, slightly encumbered by his protective suit and the gift of shining copper wire he was carrying, walked into the untidy suburbs of Tsienville, he wondered what the Europs thought of recent events. For them, there had been no eclipse of Lucifer, but the disappearance of the Great Wall must surely have been a shock. It had stood there for a thousand years, as a shield and doubtless much more; then, abruptly, it was gone, as if it had never been...

The petabyte tablet was waiting for him, with a group of Europs standing around it, demonstrating the first sign of curiosity that Poole had ever observed in them. He wondered if Halman had somehow told them to watch over this gift from space, until he came to collect it.

And to take it back, since it now contained not only a sleeping friend but terrors which some future age might exorcise, to the only place where it could be safely stored.

40

Midnight: Pico

It would be hard, Poole thought, to imagine a more peaceful scene - especially after the trauma of the last weeks. The slanting rays of a nearly full Earth revealed all the subtle details of the waterless Sea of Rains - not obliterating them, as the incandescent fury of the Sun would do.

The small convoy of mooncars was arranged in a semicircle a hundred metres from the inconspicuous opening at the base of Pico that was the entrance to the Vault. From this viewpoint, Poole could see that the mountain did not live up to the name that the early astronomers, misled by its pointed shadow, had given to it. It was more like a rounded hill than a sharp peak, and he could well believe that one of the local pastimes was

bicycle-riding to the summit. Until now, none of those sportsmen and women could have guessed at the secret hidden beneath their wheels: he hoped that the sinister knowledge would not discourage their healthy exercise.

An hour ago, with a sense of mingled sadness and triumph, he had handed over the tablet he had brought -never letting it out of his sight - from Ganymede directly to the Moon.

'Good-bye, old friends,' he had murmured. 'You've done well. Perhaps some future generation will reawaken you. But on the whole - I rather hope not.'

He could imagine, all too clearly, one desperate reason why Halman's knowledge might be needed again. By now, surely, some message was on its way to that unknown control centre, bearing the news that its servant on Europa no longer existed. With reasonable luck, it would take 950 years, give or take a few, before any response could be expected.

Poole had often cursed Einstein in the past; now he blessed him. Even the powers behind the Monoliths, it now appeared certain, could not spread their influence faster than the speed of light. So the human race should have almost a millennium to prepare for the next encounter - if there was to be one. Perhaps by that time, it would be better prepared.

Something was emerging from the tunnel - the track-mounted, semi-humanoid robot that had carried the tablet into the Vault. It was almost comic to see a machine enclosed in the kind of isolation suit used as protection against deadly germs and here on the airless Moon! But no one was taking any chances, however unlikely they might seem. After all, the robot had moved among those carefully sequestered nightmares, and although according to its video cameras everything appeared in order, there was always a chance that some vial had leaked, or some canister's seal had broken. The Moon was a very stable environment, but during the centuries it had known many quakes and meteor impacts.

The robot came to a halt fifty metres outside the tunnel. Slowly, the massive plug that sealed the Vault swung back into place, and began to rotate in its threads, like a giant bolt being screwed into the mountain.

'All not wearing dark glasses, please close your eyes or look away from the robot!' said an urgent voice over the mooncar radio. Poole twisted round in his seat, just in time to see an explosion of light on the roof of the vehicle. When he turned back to look at Pico, all that was left of the robot was a heap of glowing slag; even to someone who had spent much of his life surrounded by vacuum, it seemed altogether wrong that tendrils of smoke were not slowly spiralling up from it.

'Sterilization completed,' said the voice of the Mission Controller. 'Thank you, everybody. Now returning to Plato City.'

How ironic - that the human race had been saved by the skilful deployment of its own insanities! What moral, Poole wondered, could one possibly draw from that?

He looked back at the beautiful blue Earth, huddling beneath its tattered blanket of clouds for protection against the cold of space. Up there, a few weeks from now, he hoped to cradle his first grandson in his arms.

Whatever godlike powers and principalities lurked beyond the stars, Poole reminded himself, for ordinary humans only two things were important - Love and Death.

His body had not yet aged a hundred years: he still had plenty of time for both.

EPILOGUE

'Their little universe is very young, and its god is still a child. But it is too soon to judge them; when We return in the Last Days, We will consider what should be saved.'

SOURCES AND ACKNOWLEDGEMENTS

SOURCES

Chapter 1: The Kuiper Belt

For a description of Captain Chandler's hunting ground, discovered as recently as 1992, see 'The Kuiper Belt' by Jane X. Luu and David C. Jewitt (Scientific American, May 1996)

Chapter 3: Rehabilitation

I believed that I had invented the palm-to-palm transfer of information, so it was mortifying to discover that Nicholas ("Being Digital") Negroponte (Hodder and Stoughton, 1995) and his MIT Media Lab have been working on the idea for years...

Chapter 4: Star City

The concept of a 'ring around the world' in the geostationary orbit (CEO), linked to the Earth by towers at the Equator, may seem utterly fantastic but in fact has a firm scientific basis. It is an obvious extension of the 'space elevator' invented by the St Petersburg engineer Yuri Artsutanov, whom I had the pleasure of meeting in 1982, when his city had a different name.

Yuri pointed out that it was theoretically possible to lay a cable between the Earth and a satellite hovering over the same spot on the Equator which it does when placed in the CEO, home of most of today's communications satellites. From this beginning, a space elevator (or in Yuri's picturesque phrase, 'cosmic funicular') could be established, and payloads could be carried up to the CEO purely by electrical energy. Rocket propulsion would be needed only for the remainder of the journey.

In addition to avoiding the danger, noise and environmental hazards of rocketry, the space elevator would make possible quite astonishing reductions in the cost of all space missions. Electricity is cheap, and it would require only about a hundred dollars' worth to take one person to orbit. And the round trip would cost about ten dollars, as most of the energy would be recovered on the downward journey! (Of course, catering and in-flight movies would put up the price of the ticket. Would you believe a thousand dollars to CEO and back?)

The theory is impeccable: but does any material exist with sufficient tensile strength to hang all the way down to the Equator from an altitude of 36,000 kilometres, with enough margin left over to raise useful payloads? When Yuri wrote his paper, only one substance met these rather stringent specifications - crystalline carbon, better known as diamond. Unfortunately, the necessary megaton quantities are not readily available on the open market, though in "2061: Odyssey Three" I gave reasons for thinking that they might exist at the core of Jupiter. In "The Fountains of Paradise" I suggested a more accessible source - orbiting factories where diamonds might be grown under zero-gravity conditions.

The first 'small step' towards the space elevator was attempted in August 1992 on the Shuttle Atlantis, when one experiment involved the release - and retrieval - of a payload on a 21-kilometre-long tether. Unfortunately the playing-out mechanism jammed after only a few hundred metres.

I was very flattered when the Atlantis crew produced *The Fountains of Paradise* during their orbital press conference, and Mission Specialist Jeffrey Hoffman sent me the autographed copy on their return to Earth.

The second tether experiment, in February 1996, was slightly more successful: the payload was indeed deployed to its full distance, but during retrieval the cable was severed, owing to an electrical discharge caused by faulty insulation. This may have been a lucky accident - perhaps the equivalent of a blown fuse:

I cannot help recalling that some of Ben Franklin's contemporaries were killed when they attempted to repeat his famous - and risky - experiment of flying a kite during a thunderstorm.

Apart from possible dangers, playing-out tethered payloads from the Shuttle appears rather like fly-fishing: is not as easy as it looks. But eventually the final 'giant leap' will be made - all the way down to the Equator.

Meanwhile, the discovery of the third form of carbon, buckminsterfullerene (C₆₀) has made the concept of the space elevator much more plausible. In 1990 a group of chemists at Rice University, Houston, produced a tubular form of C₆₀ - which has far greater tensile strength than diamond. The group's leader, Dr Smalley, even went so far as to claim it was the strongest material that could ever exist - and added that it would make possible the construction of the space elevator.

(Stop Press News: I am delighted to know that Dr Smalley has shared the 1996 Nobel Prize in Chemistry for this work.)

And now for a truly amazing coincidence - one so eerie that it makes me wonder Who Is In Charge.

Buckminster Fuller died in 1983, so never lived to see the discovery of the 'buckyballs' and 'buckytubes' which have given him much greater posthumous fame. During one of the last of his many world trips, I had the pleasure of flying him and his wife Anne around Sri Lanka, and showed them some of the locations featured in *The Fountains of Paradise*. Shortly afterwards, I made a recording from the novel on a 12" (remember them?) LP record (Caedmon TC 1606) and Bucky was kind enough to write the sleeve notes. They ended with a surprising revelation, which may well have triggered my own thinking about 'Star City':

'In 1951 I designed a free-floating tensegrity ring-bridge to be installed way out from and around the Earth's equator. Within this "halo" bridge, the Earth would continue its spinning while the circular bridge would revolve at its own rate. I foresaw Earthian traffic vertically ascending to the bridge, revolving and descending at preferred Earth loci'

I have no doubt that, if the human race decides to make such an investment (a trivial one, according to some estimates of economic growth), 'Star City' could be constructed. In addition to providing new styles of living, and giving visitors from low-gravity worlds like Mars and the Moon better access to the Home Planet, it would eliminate all rocketry from the Earth's surface and relegate it to deep space, where it belongs (Though I hope there would be occasional anniversary re-enactments at Cape Kennedy, to bring back the excitement of the pioneering days.)

Almost certainly most of the City would be empty scaffolding, and only a very small fraction would be occupied or used for scientific or technological purposes. After all, each of the Towers would be the equivalent of a ten-million-floor skyscraper - and the circumference of the ring around the geostationary orbit would be more than half the distance to the Moon! Many times the entire population of the human race could be

housed in such a volume of space, if it was all enclosed. (This would pose some interesting logistics problems, which I am content to leave as 'an exercise for the student'.)

Chapter 5: Education

I was astonished to read in a newspaper on 19 July 1996 that Dr Chris Winter, head of British Telecom's Artificial Life Team, believes that the information and storage device I described in this chapter could be developed within 30 years! (In my 1956 novel *The City and the Stars* I put it more than a billion years in the future... obviously a serious failure of imagination.) Dr Winter states that it would allow us to 'recreate a person physically, emotionally and spiritually', and estimates that the memory requirements would be about 10 terabytes (10^{13} bytes), two orders of magnitude less than the petabyte (10^{15} bytes) I suggest.

And I wish I'd thought of Dr Winter's name for this device, which will certainly start some fierce debates in ecclesiastical circles: the 'Soul Catcher'... For its application to interstellar travel, see following note on Chapter 9.

For an excellent history of the 'Beanstalk' concept (as well as many other even farther-out ideas such as anti-gravity and space-warps) see Robert L. Forward's "Indistinguishable From Magic" (Baen 1995).

Chapter 7: Infinite Energy

If the inconceivable energy of the Zero Point Field (sometimes referred to as 'quantum fluctuations' or 'vacuum energy') can ever be tapped, the impact upon our civilization will be incalculable. All present sources of power - oil, coal, nuclear, hydro, solar - would become obsolete, and so

would many of our fears about environmental pollution. They would all be wrapped up in one big worry - heat pollution. All energy eventually degrades to heat, and if everyone had a few million kilowatts to play with, this planet would soon be heading the way of Venus - several hundred degrees in the shade.

However, there is a bright side to the picture: there may be no other way of averting the next Ice Age, which otherwise is inevitable ('Civilization is an interval between Ice Ages' - Will Durant: "The Story of Civilization", Fine Communications, US, 1993)

Even as I write this, many competent engineers, in laboratories all over the world, claim to be tapping this new energy source. Some idea of its magnitude is contained in a famous remark by the physicist Richard Feynman, to the effect that the energy in a coffee-mug's volume (any such volume, anywhere!) is enough to boil all the oceans of the world. This, surely, is a thought to give one pause. By comparison, nuclear energy looks as feeble as a damp match.

And how many supernovae, I wonder, really are industrial accidents?

Chapter 9: Skyland

One of the main problems of getting around in Star City would be caused by the sheer distances involved: if you wanted to visit a friend in the next Tower (and communications will never completely replace contact, despite all advances in Virtual Reality) it could be the equivalent of a trip to the Moon. Even with the fastest elevators this would involve days rather than hours, or else accelerations quite unacceptable to people who had adapted to low-gravity life.

The concept of an 'inertialess drive' - i.e. a propulsion system that acts on every atom of a body so that no strains are produced when it

accelerates - was probably invented by the master of the 'Space Opera', E.E. Smith, in the 1930s. It is not as improbable as it sounds - because a gravitational field acts in precisely this manner.

If you fall freely near the Earth (neglecting the effects of air resistance) you will increase speed by just under ten metres per second, every second. Yet you will feel weightless - there will be no sense of acceleration, even though your velocity is increasing by one kilometre a second, every minute and a half!

And this would still be true if you were falling in Jupiter's gravity (just over two-and-a-half times Earth's) or even the enormously more powerful field of a white dwarf or neutron star (millions or billions of times greater). You would feel nothing, even if you had approached the velocity of light from a standing start in a matter of minutes. However, if you were foolish enough to get within a few radii of the attracting object, its field would no longer be uniform over the whole length of your body, and tidal forces would soon tear you to pieces. For further details, see my deplorable but accurately-titled short story 'Neutron Tide' (in "The Wind from the Sun").

An 'inertialess drive', which would act exactly like a controllable gravity field, had never been discussed seriously outside the pages of science fiction until very recently. But in 1994 three American physicists did exactly this, developing some ideas of the great Russian physicist Andrei Sakharov.

'Inertia as a Zero-Point Field Lorentz Force' by B. Haisch, A. Rueda & H. F. Puthoff (Physics Review A, February 1994) may one day be regarded as a landmark paper, and for the purposes of fiction I have made it so. It addresses a problem so fundamental that it is normally taken for granted, with a that's-just-the-way-the-universe-is-made shrug of the shoulders.

The question HR&P asked is: 'What gives an object mass (or inertia) so that it requires an effort to start it moving, and exactly the same effort to restore it to its original state?'

Their provisional answer depends on the astonishing - and outside the physicists' ivory towers - little-known fact that so-called 'empty' space is actually a cauldron of seething energies - the Zero-Point Field (see note above). HR&P suggest that both inertia and gravitation are electromagnetic phenomena, resulting from interaction with this field.

There have been countless attempts, going all the way back to Faraday, to link gravity and magnetism, and although many experimenters have claimed success, none of their results has ever been verified. However, if HR&P's theory can be proved, it opens up the prospect - however remote - of anti-gravity, 'space drives' and the even more fantastic possibility of controlling inertia. This could lead to some interesting situations: if you gave someone the gentlest touch, they would promptly disappear at thousands of kilometres an hour, until they bounced off the other side of the room a fraction of a millisecond later. The good news is that traffic accidents would be virtually impossible; automobiles - and passengers - could collide harmlessly at any speed.

(And you think that today's life-styles are already too hectic?)

The 'weightlessness' which we now take for granted in space missions - and which millions of tourists will be enjoying in the next century - would have seemed like magic to our grandparents. But the abolition - or merely the reduction - of inertia is quite another matter, and may be completely impossible.* But it's a nice thought, for it could provide the equivalent of 'teleportation': you could travel anywhere (at least on Earth) almost instantaneously. Frankly, I don't know how 'Star City' could manage without it...

* As every Trekker knows, the Starship Enterprise uses 'inertial dampers' to solve this particular problem. When asked how these work, the series' technical advisor gave the only possible answer: 'very well, thank you.' (See "The Physics of Star Trek" by Lawrence Krauss: HarperCollins, 1996.)

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One of the assumptions I have made in this novel is that Einstein is correct, and that no signal - or object - can exceed the speed of light. A number of highly mathematical papers have recently appeared suggesting that, as countless science-fiction writers have taken for granted, galactic hitch-hikers may not have to suffer this annoying disability.

On the whole, I hope they are right - but there seems one fundamental objection. If FTL is possible, where are all those hitchhikers - or at least the well-heeled tourists?

One answer is that no sensible ETs will ever build interstellar vehicles, for precisely the same reason that we have never developed coal-fuelled airships: there are much better ways of doing the job.

The surprisingly small number of 'bits' required to define a human being, or to store all the information one could possibly acquire in a lifetime, is discussed in 'Machine Intelligence, the Cost of Interstellar Travel and Fermi's Paradox' by Louis K. Scheffer (Quarterly Journal of the Royal Astronomical Society, Vol. 35, No. 2, June 1994: pp. 157-75). This paper (surely the most mind-stretching that the staid QJRAS has published in its entire career!) estimates that the total mental state of a 100-year-old human with a perfect memory could be represented by 10 to the 15th bits (one petabit). Even today's optical fibres could transmit this amount of information in a matter of minutes.

My suggestion that a Star Trek transporter would still be unavailable in 3001 may therefore appear ludicrously shortsighted a mere century from now* and the present lack of interstellar tourists is simply due to the fact that no receiving equipment has yet been set up on Earth. Perhaps it's already on its way by slow-boat...

* However, for a diametrically opposing view, see the above-mentioned "Physics of Star Trek".

Chapter 15: Falcon

It gives me particular pleasure to pay this tribute to the crew of Apollo 15. On their return from the Moon they sent me the beautiful relief map of Falcon's landing site, which now has pride of place in my office. It shows the routes taken by the Lunar Rover during its three excursions, one of which skirted Earthlight Crater. The map bears the inscription: 'To Arthur Clarke from the crew of Apollo 15 with many thanks for your visions of space. Dave Scott, Al Worden, Jim Irwin.' In return, I have now dedicated "Earthlight" (which, written in 1953, was set in the territory the Rover was to drive over in 1971): 'To Dave Scott and Jim Irwin, the first men to enter this land, and to Al Worden, who watched over them from orbit.'

After covering the Apollo 15 landing in the CBS studio with Walter Cronkite and Wally Schirra, I flew to Mission Control to watch the re-entry and splashdown. I was sitting beside Al Worden's little daughter when she was the first to notice that one of the capsule's three parachutes

had failed to deploy. It was a tense moment, but luckily the remaining two were quite adequate for the job.

Chapter 16: Asteroid 7794

See Chapter 18 of "2001: A Space Odyssey" for the description of the probe's impact. Precisely such an experiment is now being planned for the forthcoming Clementine 2 mission.

I am a little embarrassed to see that in my first Space Odyssey the discovery of Asteroid 7794 was attributed to the Lunar Observatory - in 1997! Well, I'll move it to 2017 - in time for my 100th birthday.

Just a few hours after writing the above, I was delighted to learn that Asteroid 4923 (1981 EO27), discovered by S. J. Bus at Siding Spring, Australia, on 2 March 1981, has been named Clarke, partly in recognition of Project Spaceguard (see "Rendezvous with Rama" and "The Hammer of God"). I was informed, with profound apologies, that owing to an unfortunate oversight Number 2001 was no longer available, having been allocated to somebody named A. Einstein. Excuses, excuses.

But I was very pleased to learn that Asteroid 5020, discovered on the same day as 4923, has been named Asimov - though saddened by the fact that my old friend could never know.

Chapter 17: Ganymede

As explained in the Valediction, and in the Author's Notes to "2010 Odyssey Two" and "2061 Odyssey Three", I had hoped that the ambitious Galileo Mission to Jupiter and its moons would by now have given us

much more detailed knowledge - as well as stunning close-ups - of these strange worlds.

Well, after many delays, Galileo reached its first objective - Jupiter itself - and is performing admirably. But, alas, there is a problem - for some reason, the main antenna never unfolded. This means that images have to be sent back via a low-gain antenna, at an agonizingly slow rate. Although miracles of onboard computer reprogramming have been done to compensate for this, it will still require hours to receive information that should have been sent in minutes.

So we must be patient - and I was in the tantalizing position of exploring Ganymede in fiction just before Galileo started to do so in reality, on 27 June 1996.

On 11 July 1996, just two days before finishing this book, I downloaded the first images from JPL; luckily nothing - so far! -contradicts my descriptions. But if the current vistas of cratered ice-fields suddenly give way to palm trees and tropical beaches - or, worse still, YANKEE GO HOME signs, I'll be in real trouble .

I am particularly looking forward to close-ups of 'Ganymede City' (Chapter 17). This striking formation is exactly as I described it - though I hesitated to do so for fear that my 'discovery' might be front-paged by the National Prevaricator. To my eyes it appears considerably more artificial than the notorious 'Mars Face' and its surroundings. And if its streets and avenues are ten kilometres wide - so what? Perhaps the Medes were BIG...

The city will be found on the NASA Voyager images 20637.02 and 20637.29, or more conveniently in Figure 23.8 of John H. Rogers's monumental "The Giant Planet Jupiter" (Cambridge University Press, 1995).

Chapter 19: The Madness of Mankind

For visual evidence supporting Khan's startling assertion that most of mankind has been at least partially insane, see Episode 22, 'Meeting Mary', in my television series Arthur C. Clarke's Mysterious Universe. And bear in mind that Christians represent only a very small subset of our species: far greater numbers of devotees than have ever worshipped the Virgin Mary have given equal reverence to such totally incompatible divinities as Rama, Kali, Siva, Thor, Wotan, Jupiter, Osiris, etc. etc....

The most striking - and pitiful - example of a brilliant man whose beliefs turned him into a raving lunatic is that of Conan Doyle. Despite endless exposures of his favourite psychics as frauds, his faith in them remained unshaken. And the creator of Sherlock Holmes even tried to convince the great magician Harry Houdini that he 'dematerialized' himself to perform his feats of escapology - often based on tricks which, as Dr Watson was fond of saying, were 'absurdly simple'. (See the essay 'The Irrelevance of Conan Doyle' in Martin Gardner's "The Night is Large", St Martin's Press, US, 1996.)

For details of the Inquisition, whose pious atrocities make Pol Pot look positively benign, see Carl Sagan's devastating attack on New Age Nitwittery, "The Demon-Haunted World: Science as a Candle in the Dark" (Headline, 1995). I wish it - and Martin's book - could be made required reading in every high school and college.

At least the US Department of Immigration has taken action against one religion-inspired barbarity. Time Magazine ('Milestones', 24 June 1996) reports that asylum must now be granted to girls threatened with genital mutilation in their countries of origin.

I had already written this chapter when I came across Anthony Storr's "Feet of Clay: A Study of Gurus" (HarperCollins, 1996), which is a virtual textbook on this depressing subject. It is hard to believe that one holy fraud, by the time the US Marshals belatedly arrested him, had

accumulated ninety-three Rolls-Royces! Even worse - eighty-three per cent of his thousands of American dupes had been to college, and thus qualify for my favourite definition of an intellectual: 'Someone who has been educated beyond his/her intelligence.'

Chapter 26: Tsienville

In the 1982 preface to "2010: Odyssey Two", I explained why I named the Chinese spaceship which landed on Europa after Dr Tsien Hsue-shen, one of the founders of the United States and Chinese rocket programmers. As Iris Chang states in her biography "Thread of the Silkworm" (Basic Books, 1995) 'his life is one of the supreme ironies of the Cold War'.

Born in 1911, Tsien won a scholarship which brought him from China to the United States in 1935, where he became student and later colleague of the brilliant Hungarian aerodynamicist Theodore von Karman. Later, as first Goddard Professor at the California Institute of Technology, he helped establish the Guggenheim Aeronautical Laboratory - the direct ancestor of Pasadena's famed Jet Propulsion Laboratory.

With top secret clearance, he contributed greatly to American rocket research in the 1950s, but during the hysteria of the McCarthy era was arrested on trumped-up security charges when he attempted to pay a visit to his native China. After many hearings and a prolonged period of arrest, he was finally deported to his homeland - with all his unrivalled knowledge and expertise. As many of his distinguished colleagues affirmed, it was one of the most stupid (as well as most disgraceful) things the United States ever did.

After his expulsion, according to Thuang Fenggan, Deputy Director, China National Space Administration, Tsien 'started the rocket business from nothing... Without him, China would have suffered a twenty-year lag in technology.' And a corresponding delay, perhaps, in the deployment of

the deadly 'Silkworm' anti-ship missile and the 'Long March' satellite launcher.

Shortly after I had completed this novel, the International Academy of Astronautics honoured me with its highest distinction, the von Karman Award - to be given in Beijing! This was an offer I couldn't refuse, especially when I learned that Dr Tsien is now a resident of that city. Unfortunately, when I arrived there I discovered that he was in hospital for observation, and his doctors would not permit visitors.

I am therefore extremely grateful to his personal assistant, Major-General Wang Shouyun, for carrying suitably inscribed copies of 2010 and 2061 to Dr Tsien. In return the General presented me with the massive volume he has edited, "Collected Works of H. S. Tsien: 1938-1956" (1991, Science Press, 16, Donghuangcheggen North Street, Beijing 100707). It is a fascinating collection, beginning with numerous collaborations with von Karman on problems in aerodynamics, and ending with solo papers on rockets and satellites. The very last entry, 'Thermonuclear Power Plants' (Jet Propulsion, July 1956) was written while Dr Tsien was still a virtual prisoner of the FBI, and deals with a subject that is even more topical today - though very little progress has been made towards 'a power station utilizing the deuterium fusion reaction'.

Just before I left Beijing on 13 October 1996 I was happy to learn that, despite his current age (85) and disability, Dr Tsien is still pursuing his scientific studies. I sincerely hope that he enjoyed "2010" and "2061", and look forward to sending him this "Final Odyssey" as an additional tribute.

Chapter 36: Chamber of Horrors

As the result of a series of Senate Hearings on Computer Security in June 1996, on 15 July 1996 President Clinton signed Executive Order

13010 to deal with 'computer-based attacks on the information or communications components that control critical infrastructures ("cyber threats").' This will set up a task force to counter cyberterrorism, and will have representatives from the CIA, NSA, defense agencies, etc.

Pico, here we come...

Since writing the above paragraph, I have been intrigued to learn that the finale of the movie Independence Day, which I have not yet seen, also involves the use of computer viruses as Trojan horses! I am also informed that its opening is identical to that of Childhood's End (1953), and that it contains every known science-fiction cliché since Me'lie`s's Trip to the Moon (1903).

I cannot decide whether to congratulate the script-writers on their one stroke of originality - or to accuse them of the transtemporal crime of pre-cognitive plagiarism. In any event, I fear there's nothing I can do to stop John Q. Popcorn thinking that I have ripped off the ending of ID4.

The following material has been taken - usually with major editing - from the earlier books in the series:

From "2001 A Space Odyssey": Chapter 18 Through the Asteroids and Chapter 37 Experiment.

From "2010: Odyssey Two": Chapter 11 Ice and Vacuum; Chapter 36 Fire in the Deep; Chapter 38 Foamscape.

ACKNOWLEDGEMENTS

My thanks to IBM for presenting me with the beautiful little Thinkpad 755CD on which this book was composed. For many years I have been embarrassed by the - totally unfounded -rumour that the name HAL was derived by one-letter displacement from IBM. In an attempt to exorcise this computer-age myth, I even went to the trouble of getting Dr Chandra, HAL's inventor, to deny it in 2010 Odyssey Two. However, I was recently assured that, far from being annoyed by the association, Big Blue is now quite proud of it. So I will abandon any future attempts to put the record straight - and send my congratulations to all those participating in HAL's 'birthday party' at (of course) the University of Illinois, Urbana, on 12 March 1997.

Rueful gratitude to my Del Rey Books editor, Shelly Shapiro, for ten pages of niggles which, when dealt with, made a vast improvement to the final product. (Yes, I've been an editor myself, and do not suffer from the usual author's conviction that the members of this trade are frustrated butchers.)

Finally, and most important of all: my deepest thanks to my old friend Cyril Gardiner, Chairman of the Galle Face Hotel, for the hospitality of his magnificent (and enormous) personal suite while I was writing this book: he gave me a Tranquillity Base in a time of troubles. I hasten to add that, even though it may not provide such extensive imaginary landscapes, the facilities of the Galle Face are far superior to those offered by the 'Grannymede', and never in my life have I worked in more comfortable surroundings.

Or, for that matter, in more inspirational ones, for a large plaque at the entrance lists more than a hundred of the Heads of State and other distinguished visitors who have been entertained here. They include Yuri

Gagarin, the crew of Apollo 12 - the second mission to the Moon's surface - and a fine collection of stage and movie stars: Gregory Peck, Alec Guinness, Noel Coward, Carrie Fisher of "Star Wars" fame... As well as Vivien Leigh and Laurence Olivier - both of whom make brief appearances in "2061 Odyssey Three" (Chapter 37). I am honoured to see my name listed among them.

It seems appropriate that a project begun in one famous hotel - New York's Chelsea, that hotbed of genuine and imitation genius - should be concluded in another, half a world away. But it's strange to hear the monsoon-lashed Indian Ocean roaring just a few yards outside my window, instead of the traffic along far-off and fondly remembered 23rd Street.

IN MEMORIAM: 18 SEPTEMBER 1996

It was with the deepest regret that I heard - literally while editing this acknowledgements - that Cyril Gardiner died a few hours ago. It is some consolation to know that he had already seen the above tribute and was delighted with it.

VALEDICTION

'Never explain, never apologize' may be excellent advice for politicians, Hollywood moguls and business tycoons, but an author should treat his readers with more consideration. So, though I have no intention of apologizing for anything, perhaps the complicated genesis of the Odyssey Quartet requires a little explaining.

It all began at Christmas 1948 - yes, 1948! - with a 4,000-word short story which I wrote for a contest sponsored by the British Broadcasting Corporation. 'The Sentinel' described the discovery of a small pyramid on the Moon, set there by some alien civilization to await the emergence of mankind as a planet-faring species. Until then, it was implied, we would be too primitive to be of any interest.* The BBC rejected my modest effort, and it was not published until almost three years later in the one-and-only (Spring 1951) issue of 10 Story Fantasy - a magazine which, as the invaluable "Encyclopaedia of Science Fiction" wryly comments, is 'primarily remembered for its poor arithmetic (there were 13 stories)'.

'The Sentinel' remained in limbo for more than a decade, until Stanley Kubrick contacted me in the spring of 1964 and asked if I had any ideas for the 'proverbial' (i.e. still non-existent) 'good science-fiction movie'. During the course of our many brainstorming sessions, as recounted in "The Lost Worlds of 2001" (Sidgwick and Jackson, 1972) we decided that the patient watcher on the Moon might provide a good starting point for our story. Eventually it did much more than that, as somewhere during production the pyramid evolved into the now famous black monolith.

* The search for alien artefacts in the Solar System should be a perfectly legitimate branch of science ('exo-archaeology?'). Unfortunately, it has been largely discredited by claims that such evidence has already been found - and has been deliberately suppressed by NASA! It is incredible that anyone would believe such nonsense: far more likely that the space agency would deliberately fake ET artefacts - to solve its budget problems! (Over to you, NASA Administrators...)

To put the Odyssey series in perspective, it must be remembered that when Stanley and I started planning what we privately called 'How the Solar System was Won' the Space Age was barely seven years old, and no human had travelled more than a hundred kilometres from the home planet. Although President Kennedy had announced that the United States intended to go to the Moon 'in this decade', to most people that must still have seemed like a far-off dream. When filming started just west of London* on a freezing 29 December 1965, we did not even know what the lunar surface looked like at close quarters. There were still fears that the first word uttered by an emerging astronaut would be 'Help!' as he disappeared into a talcum-power-like layer of moondust. On the whole, we guessed fairly well: only the fact that our lunar landscapes are more jagged than the real ones - smoothed by aeons of sand-blasting by meteoric dust - reveals that 2001 was made in the pre-Apollo era.

* At Shepperton, destroyed by the Martians in one of the most dramatic scenes in Wells's masterpiece, *The War of the Worlds*.

Today, of course, it seems ludicrous that we could have imagined giant space-stations, orbiting Hilton Hotels, and expeditions to Jupiter as early as 2001. It is now difficult to realize that back in the 1960s there were serious plans for permanent Moon bases and Mars landings - by 1990! Indeed, in the CBS studio, immediately after the Apollo 11 launch, I heard the Vice-President of the United States proclaim exuberantly: 'Now we must go to Mars!'

As it turned out, he was lucky not to go to prison. That scandal, plus Vietnam and Watergate, is one of the reasons why these optimistic scenarios never materialized.

When the movie and book of "2001 A Space Odyssey" made their appearance in 1968, the possibility of a sequel had never crossed my mind. But in 1979 a mission to Jupiter really did take place, and we obtained our first close-ups of the giant planet and its astonishing family of moons.

The Voyager space-probes* were, of course, unmanned, but the images they sent back made real - and totally unexpected - worlds from what had hitherto been merely points of light in the most powerful telescopes. The continually erupting sulphur volcanoes of Io, the multiply-impacted face of Callisto, the weirdly contoured landscape of Ganymede - it was almost as if we had discovered a whole new Solar System. The temptation to explore it was irresistible; hence 2010 Odyssey Two, which also gave me the opportunity to find out what happened to David Bowman, after he had awakened in that enigmatic hotel room.

* Which employed a 'slingshot' or 'gravity-assist' manoeuvre by flying close to Jupiter

In 1981, when I started writing the new book, the Cold War was still in progress, and I felt I was going out on a limb - as well as risking criticism - by showing a joint US-Russian mission. I also underlined my hope of future co-operation by dedicating the novel to Nobelist Andrei Sakharov (then still in exile) and Cosmonaut Alexei Leonov - who, when I told him

in 'Star Village' that the ship would be named after him, exclaimed, with typical ebullience, 'Then it will be a good ship!'

It still seems incredible to me that, when Peter Hyams made his excellent film version in 1983, he was able to use the actual close-ups of the Jovian moons obtained in the Voyager missions (some of them after helpful computer processing by the Jet Propulsion Laboratory, source of the originals). However, far better images were expected from the ambitious Galileo mission, due to carry out a detailed survey of the major satellites over a period of many months. Our knowledge of this new territory, previously obtained only from a brief flyby, would be enormously expanded - and I would have no excuse for not writing "Odyssey Three".

Alas - something tragic on the way to Jupiter. It had been planned to launch Galileo from the Space Shuttle in 1986 - but the Challenger disaster ruled out that option, and it soon became clear - precisely as was done by Discovery in the book version of 2001 - that we would get no new information from Io and Europa, Ganymede and Callisto, for at least another decade.

I decided not to wait, and the (1985) return of Halley's Comet to the inner Solar System gave me an irresistible theme. Its next appearance in 2061 would be good timing for a third Odyssey, though as I was not certain when I could deliver it I asked my publisher for a rather modest advance. It is with much sadness that I quote the dedication of "2061 Odyssey Three":

TO THE MEMORY OF
JUDY-LYNN DEL REY,
EDITOR EXTRAORDINARY,

who bought this book for one dollar

- but never knew if she got her money's worth.

Obviously there is no way in which a series of four science-fiction novels, written over a period of more than thirty years of the most breathtaking developments in technology (especially in space exploration) and politics, could be mutually consistent. As I wrote in the introduction to 2061: 'Just as 2010 was not a direct sequel to 2001, so this book is a not a linear sequel to 2010. They must all be considered as variations on the same theme, involving many of the same characters and situations, but not necessarily happening in the same universe.' If you want a good analogy from another medium, listen to what Rachmaninoff and Andrew Lloyd Webber did to the same handful of notes by Paganini.

So this "Final Odyssey" has discarded many of the elements of its precursors, but developed others - and I hope more important ones - in much greater detail. And if any readers of the earlier books feel disorientated by such transmutations, I hope I can dissuade them from sending me angry letters of denunciation by adapting one of the more endearing remarks of a certain US President: 'It's fiction, stupid!'

And it's all my own fiction, in case you hadn't noticed. Though I have much enjoyed my collaborations with Gentry Lee,* Michael Kube-McDowell and the late Mike McQuay - and won't hesitate again to call on the best hired guns in the business if I have future projects that are too big to handle myself - this particular Odyssey had to be a solo job.

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* By an unlikely coincidence, Gentry was Chief Engineer on the Galileo and Viking projects. (See Introduction to Rama II). It wasn't his fault that the Galileo antenna didn't unfurl...

So every word is mine: well, almost every word, I must confess that I found Professor Thirugnanasampanthamoorthy (Chapter 35) in the Colombo Telephone Directory; I hope the present owner of that name will not object to the loan. There are also a few borrowings from the great Oxford English Dictionary. And what do you know - to my delighted surprise, I find it uses no fewer than 66 quotations from my own books to illustrate the meaning and use of words!

Dear OED, if you find any useful examples in these pages, please be my guest - again.

I apologize for the number of modest coughs (about ten, at last count) in this Afterword; but the matters to which they drew attention seemed too relevant to be omitted.

Finally, I would like to assure my many Buddhist, Christian, Hindu, Jewish and Muslim friends that I am sincerely happy that the religion which Chance has given you has contributed to your peace of mind (and often, as Western medical science now reluctantly admits, to your physical well-being).

Perhaps it is better to be un-sane and happy, than sane and un-happy. But it is best of all to be sane and happy.

Whether our descendants can achieve that goal will be the greatest challenge of the future. Indeed, it may well decide whether we have any future.

Arthur C. Clarke
Colombo, Sri Lanka
19 September 1996

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