Third Scientific Lecture-Course:

Astronomy

The Relation of the Diverse Branches of Natural Science to Astronomy

By Rudolf Steiner

GA 323

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Content:

Note by the Editor of the original edition, Dornach, 1926
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"God ever geometrizes," the Greek scholar Plato said. Plato was probably thinking about the shapes of fruit, of leaves, of the moon, of many things in nature that have interesting and beautiful forms. In any case, his remark tells something about the interest the Greeks had in geometry. It was mainly through geometry that the Greeks changed the face of mathematics in a period of a few hundred years before the birth of Christ. Greek mathematics did include some other things-arithmetic, by which they meant the study of numbers; logistics which was what we would now call arithmetic, or calculation for practical purposes; and a kind of algebra, with which they described number relationships in words. Today we use letters and other symbols. But above all, it included geometry, which was where their real interest lay.

As you read in Chapter 2, geometry began long before the Greeks became interested in it. The "earth measurement" of the Egyptians is an example of how geometry was used in the earliest days of mathematics. It was used, in short, for measuring things. The Greeks, on the other hand, liked geometry for its own sake. They liked to draw triangles and circles and other shapes and see what rules they could discover for problems like finding the circumference of a circle and the amount of space occupied by a circle, or for working out the unknown dimensions of a triangle from known dimensions such as the length of sides and the size of angles, as is shown by the geometric construction on the left.

In doing such things the Greeks brought to geometry three new ideas that were of great importance for the future of mathematics. Those ideas were deduction, proof, and abstraction.

Deduction involves using known facts, or at least facts on which we agree, to reach conclusions that necessarily follow from those facts. For example, let us take as the known facts, or premises, the statements that all apples are red, and that you are holding an apple in your hand. It necessarily follows from the premises that the object in your hand is red. It does not make any difference that there are also green apples and yellow apples;

the point is that for the premises that are given, the conclusion is the correct one. Deduction, in other words, is a reasoning process throughout which you can build on what you know and thereby expand your knowledge.

Foreword

With this work there appears in print the richest in scope and indeed the most comprehensive of the Natural Science Courses held by Rudolf Steiner before the teachers of the Waldorf School. In no other Course has the great teacher given so such of the foundations of method and so such of what is needed to link up the single sciences with one another as in this "Astronomical Course," to which in his opening words he expressly gave the title "The Relation of the different Branches of Natural Science to Astronomy."

Natural scientists, medical doctors, mathematicians and astronomers were directed towards ways in which to overcome the separation of their various domains. At the same time the most significant indications were given to the specialist, by which he night re-organise his own special sphere in the sense of a science based on spiritual knowledge. An immeasurable feeling of responsibility and duty is aroused by this gift of wisdom; all the more so when its creator no longer lives among us physically.

A short time before his death he was able to accept the study on this Course by W. Kaiser (Astronomy in the Light of Spiritual Science: Published by Der Kommende Tag) but this, his own work, we can only dedicate to his eternal spirit, which remains united with all his work when it is carried forward in his spirit.

Before being printed, the text of the shorthand notes was carefully revised. My cordial thanks for this responsible task are due to Herr E. A. Stockmeyer of the Waldorf School in Stuttgart for his ready assistance.

For the Mathematical and Astronomical Section

E. VREEDE
DORNACH
The GOETHEANUM
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Lecture I
Stuttgart, January 1, 1921

My dear friends!

To-day I should like to make some introductory remarks to what I am going to lay before you in the coming days. My reason for doing this is that you may know the purpose of these talks from the outset.

It will not be my task during the following days to deal with any narrowly defined, special branch of science, but to give various wider viewpoints, having in mind a quite definite goal in relation to science. I should therefore like to warn people not to describe this as an 'Astronomical Course'. It is not meant to be that. But it will deal with something that I feel is especially important for us to consider at this time. I have therefore given it the title "The relation of the diverse branches of Natural Science to Astronomy," and today in particular I shall explain what I actually intend with the giving of this title.

The fact is that in a comparatively short time much will have to be changed within what we call the sphere of science, if it is not to enter upon a complete decline. Certain groups of sciences which are now comprised under various headings and are permitted to be represented under these headings, in our ordinary schools, will have to be taken out their grooves and be classified from quite other aspects. This will necessitate a far reaching regrouping of our sciences. The grouping at present employed is entirely inadequate for a world-conception based upon reality, and yet our modern world holds so firmly to such traditional classification that it is on this basis that candidates are chosen to occupy the professorial chairs in our Universities. People confine themselves for the most part to dividing the existing, circumscribed fields of Natural Science into yet further special branches, and they then look to the specialists or experts as they are called. But a change must come into the whole scientific life by the advent of quite different categories, within which will be united, as in a whole new field of science, things that today are dealt with in Zoology or Physiology, or again, let us say, in the Theory of Knowledge. The older forms of scientific classification, often extremely abstract, must die out, and quite new scientific combinations must arise. This will meet with great obstacles at first, because people today are trained in the specialized branches of science and it will be difficult for them to find an approach to what they will urgently need in order to bring about a combination of scientific material in accordance with reality.

To put in concisely, I might say: We have today a science of astronomy, of Physics, of Chemistry, of Philosophy, we have a science of Biology, of Mathematics, and so on. Special branches have been formed, almost, I might say, so that the various specialists will not have such hard work in order to become well grounded in their subject. They do not have too much to do in mastering all the literature concerned, which, as we know, exists in immense quantities. But it will be a matter of creating new branches which will comprise quite different things, including perhaps at the same time something from Astronomy, something from Biology, and so on. For this, a reshaping of our whole life of science will of course be essential. Therefore, what we term Spiritual Science, which does indeed aim to be of a universal nature, must work precisely in this direction. It must make it its special mission to work in this direction. For we simply cannot get any further with the old grouping. Our Universities confront the world today, my dear friends, in a way that is really quite estranged from life. They turn out mathematicians, physiologists, philosophers, but none of them have any real relation to the world. They can do nothing but work in their narrowly confined spheres, putting before us a picture of the world that becomes more and more abstract, less and less realistic.

It is the change here indicated — a deep necessity for our time — to which I want to do justice in these lectures. I should like you to see how impossible it will be to continue the older classifications indefinitely, and I therefore want to show how other branches of science of the most varied kinds, which, in their present way of treatment, take no account of Astronomy, have indeed definite

connections with Astronomy, that is, with a true knowledge of universal space. Certain astronomical facts must perforce be taken into account in other branches of science too, so that we may learn to master these other fields in a way conformable to reality.

The task of these lectures is therefore to build a bridge from the different fields of scientific thought to the field of Astronomy, that astronomical understanding may appear in the right way in the various fields of science.

In order not to be misunderstood, I should like to make one more remark about method. You see, the manner of presenting scientific facts which is customary nowadays must undergo considerable change, because it actually arises out of the scientific structure which has to be overcome. When today facts are referred to, which lie somewhat remote from man's understanding, — remote, just because he does not meet with them at all in his scientific knowledge, — it is usual to say: "That is stated, but no proved." Yet in scientific work is often quite inevitable that statements must be made at first purely as results of observation, which only afterwards can be verified as more and more facts are brought to support them. So it would be wrong to assume, for instance, that right at the beginning of a discourse someone could break in and say, "That is not proved." It will be proved in the course of time, but much will first have to be presented simply from observation, so that the right concept, the right idea, may be created.

And so I beg of you to take these lectures as a whole, and to look in the last lectures for the plain proof of many things which seem in the first lectures to be mere statements. Many things will then be verified which I shall have to handle at first in such a way as to evoke the necessary concepts and ideas.

Astronomy as we know it today, even including the domain of Astrophysics, is fundamentally a modern creation. Before the time of Copernicus of Galileo men thought about astronomical phenomena in a way which differed essentially from the way we think today. It is even extraordinarily difficult to indicate the way in which man still thought of Astronomy in, say, the 13th and 14th centuries, because this way of thinking has become completely foreign to modern man. We only live in the ideas which have been formed since the time of Galileo, Kepler, Copernicus; and from a certain point of view that is perfectly right. They are ideas which treat of the distant phenomena of universal space, in so far as they are concerned with Astronomy, in a mathematical and mechanical way. Men think of these phenomena in terms of mathematics and mechanics. In observing the phenomena, men base their ideas upon what they have acquired from an abstract mathematical science, or an abstract science of mechanics. They calculate distances, movements and forces. But the qualitative outlook still in existence in the 13th and 14th centuries, which distinguished Individualities in the stars, an Individuality of Jupiter, of Saturn ... this has become completely lost to modern man. I will make no criticism of the things at the moment, but will only point out that the mechanical and mathematical way of treating what we call the domain of Astronomy has become the exclusive one. Even if we acquaint ourselves with the stars in a popular fashion without understanding mathematics or mechanics, we still find it presented, even if in a manner suitable for the lay-mind, entirely in ideas of space and time, of a mathematical and mechanical kind. No doubts of any kind exist in the minds of our contemporaries — who believe that their judgment is authoritative — that this is the only way in which to regard the starry heavens. Anything else, they are convinced, would be merely amateurish.

Now, if the question arises as to how it has actually come about that this view of the starry heavens has emerged in the evolution of civilization, the answer of those who regard the modern scientific mode of thought as absolute, will be different from the reply which we are able to give. Those who regard the scientific thought of today as something absolute and true, will say: Well, you know, among earlier humanity there were not yet any strictly scientifically formed ideas; man had first to struggle through to such ideas, i. e., to the mathematical, mechanical mode of regarding celestial phenomena of the Universe, a later humanity has worked through to a strictly scientific comprehension of what does actually correspond to reality.

This is an answer that we cannot give, my dear friends. We must take up our position from the standpoint of the evolution of humanity, which in the course of its existence, has introduced various inner forces into its consciousness. We must say to ourselves: The manner of observing the celestial phenomena which existed among the ancient Babylonians, the Egyptians, perhaps even the Indian people, was due to the particular form which the development of the human soul-forces was taking in those times. Those human soul-forces had to be developed with the same inner necessity with which a child between the 10th and 15th year must develop certain soul-forces, while in another period it will developing other faculties, which lead it to different conclusions about the world. Then came the Ptolemaic system. That arose out of different soul-forces. Then our Copernican system. That arose from yet other soul-forces. The Copernican system did not develop because humanity had happily struggled through to objectivity, whereas before they had all been as children, but because humanity since the middle of the 15th century needed precisely the mathematical, mechanical faculties for its development. That is why modern man sees the celestial phenomena in the picture formed by the mathematical, mechanical faculties. And he will some day see them again in a different way, when in his development he has drawn up out of the depths of the soul other forces, — to his own healing and benefit. Thus it depends upon humanity what form the world-concept takes. But it is not a question of looking back in pride to earlier times when men were "more childlike," and then thinking that in modern times we have at last struggled through to an objective understanding which can now endure for all future ages.

There is something which has become a real necessity to later humanity and has given color to the requirements of the scientific mind. It is this: Men strive on the one hand for ideas that are clear and easy to control — namely, mathematical ideas — , and on the other hand they strive for ideas through which they can surrender most strongly to an inner compulsion. The modern man at once becomes uncertain and nervous when he does no feel the strong inner compulsion presented, for instance, by the argument of the Pythagorean theorem, but realizes, let us say, the the figure which is draw does not decide for him, but that he must develop an activity of soul and decide for himself. Then he at once becomes uncertain and nervous and is no longer willing to continue the line of thought. So he says: That is not exact science; subjectivity comes into it. Modern man is really dreadfully passive; he would like to be led everywhere by a chain of infallible arguments and conclusions. Mathematics satisfies this requirement, at least in most cases; and where it does not, where man have interposed their own opinion in recent times, — well, my dear friends, the results are according! Men still believe that they are being exact, while they hit upon the most incredible ideas.

Thus in mathematics and mechanics men think they are being led forward by leading-strings of concepts which are linked together through their own inherent logic. They feel then as if they had ground under their feet, but the moment they step off it they do not want to go on any further. Concepts which are easy to grasp on the one hand, and the element of inner compulsion on the other: this is what modern man needs for his "safety." Fundamentally, it is on this basis that the particular form of world-conception, supplied by the modern science of Astronomy, has been built up. I am not at the moment speaking of the single facts, but merely of the world-conception as a whole.

This attitude towards a mathematical, mechanical conception of the world has so penetrated the consciousness of humanity, my dear friends, that people have come to regard everything that cannot be treated in this way as more or less unscientific. From this feeling proceeded such a phrase as that of Kant, who said: In every domain of science there is only so much real science as there is mathematics in it; one ought really to bring Arithmetic or Geometry into all the sciences. But this idea, as we know, breaks down when we think how remote the simplest mathematical ideas are to those, for instance, who study Medicine. Our present division of the sciences gives to a medical student practically nothing in the way of mathematical ideas.

And so it comes about that on the one hand what is called astronomical knowledge has been set up as an ideal. DuBois-Raymond has defined this in his address on the limits of the knowledge of Nature by saying: We only grasp truths in Nature and satisfy our need of causality inasmuch as we can apply the astronomical type of knowledge. That is to say, we regard the celestial phenomena in such a sway

that we draw the stars upon the chart of the sky and calculate with the material which is there given us. We can state exactly: There is a star, it exercises a force of attraction upon other stars. We begin to calculate, having the different things, to which our calculations apply, visibly before us. This is what we have brought into Astronomy in the first place. Now we observe, let us say, the molecule. Within the complex molecule we have the atoms, exercising a force of attraction on one another, moving around each other, — forming, as it were, a little universe. We observe this molecule as a small cosmic system and are satisfied if it all seems to fit. But then there is the great difference that when we look out into the starry sky all the details are given to us. We can at most ask whether we understand them rightly, whether after all, there might not be some other explanation than the one given by Newton. We have the given details and then we spin a mathematical, mechanical web over them. This web of thought is actually added to the given facts, but from a scientific point of view it satisfies the modern need of man. And now we carry the system, which we have first thought out and devised, into the world of the molecule and atom. Here we add in thought what in the other case was given to us. But we satisfy our so-called need of causality by saying: What we think of as the smallest particle, moves in such and such a way, and it is the objective counterpart of what we experience subjectively as light, sound, warmth etc. We carry the astronomic form of knowledge into every phenomenon of the world and thus satisfy our demand for causality. Du-Bois Raymond has expressed it quite bluntly: "When one cannot do that, there is no scientific explanation at all."

Yes, my dear friends, what is here claimed should actually imply that if, for example, we wished to come to a rational form of therapy, that is to say, to understand the activity of a remedy, we should have to be able to follow the atoms in the substance of the remedy as we follow the movements of the Moon, the Sun, the planets and the fixed stars. They would all have to become little cosmic systems. We should have to be able to calculate how this or that remedy would work. This was actually an ideal for some people not so very long ago. Now they have given up such ideals. Such an idea collapses not only in reference to such a far off sphere as a rational therapy, but in those lying more within reach, simply because our sciences are divided as they are today. You see, the modern doctor is educated in such a way that he masters extraordinarily little of pure mathematics. We may talk to him perhaps of the need for a knowledge of astronomy but it would be of no use to speak of introducing mathematical ideas into his field of work. But as we have seen, everything outside mathematics, mechanics and astronomy should be described, according to the modern notion, as being unscientific in the strict sense of the word. Naturally that is not done. People regard these other sciences too as exact, but this is most inconsistent. It is, however, characteristic of the present time that the demand should have been made at all for everything to be understood on the model of mathematical Astronomy.

It is hard today to talk to people in a serious way about such thing; how hard this is I should like to make clear to you by an example.

You know of course that the question of the form of the human skull has played a great role in modern biology. I have also spoken of this matter may times in the course of our anthroposophical lectures. Goethe and Oken put forward magnificent thoughts on this question of the human skull-bones. The school of Gegenbauer also carried out classical researches upon it. But something that could satisfy the urge for a deeper knowledge in this direction does not in fact exist today.

People discuss, to what extent was Goethe right in saying that the skull-bones are metamorphosed vertebrae, bones of the spine. But it is impossible to arrive at any really penetrating view of this matter today, because in the circles where these things are discussed one would scarcely be understood, and where an understanding might be forthcoming these things are not talked of because they are not of interest. You see, it is practically impossible today to bring together in close working association a thoroughly modern doctor, a thoroughly modern mathematician, — i.e., one who is master of higher mathematics — , and a man who could understand both of them passably well. These three men could scarcely understand one another. The one who would sit in the middle, understanding both of them slightly, would be able at a pinch to talk a little with the mathematician and also with the doctor. But the mathematician and the doctor would not be able to understand each other upon important questions, because what the doctor would have to say about them would not interest the

mathematician, and what the mathematician would have to say — or would say, if he found words at all, — would not be understood by the doctor, who would be lacking the necessary mathematical background. This is what would happen in an attempt to solve the problem I have just put before you. People imagine: If the skull-bones are metamorphosed vertebra, then we ought to be able to proceed directly, through a transformation which it is possible to picture spatially, from the vertebra to the skull. To extend the idea still further to the limb-bones would, on the basis of the accepted premises, be quite out of the question. The modern mathematician will be able, from his mathematical studies, to form an idea of what it really means when I turn a glove inside out, when I turn the inside to the outside. One must have in mind a certain mathematical handling of the process by which what was formerly outside is turned inward, and what was inside is turned to the outside. I will make a sketch of it (Fig. 1) — a structure of some sort that is first white on the outside and red inside. We will treat this structure as we did the glove, so that it is now red outside and white inside (Fig. 2).

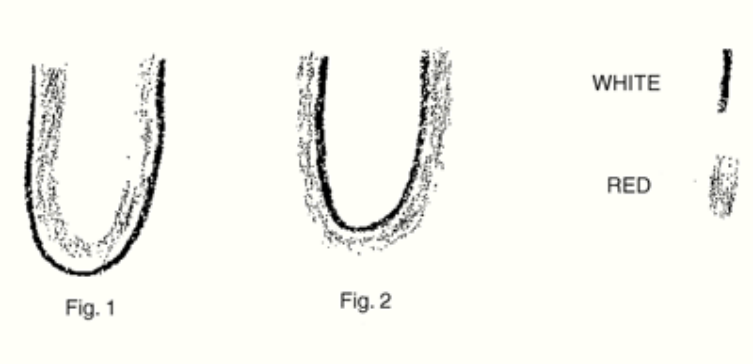

Fig. 1 Fig. 2

But let us go further, my dear friends, and picture to ourselves that we have something endowed with a force of its own that does not admit of being turned inside out in such a simple way as a glove which still looks like a glove after being inverted. Suppose that we invert something which has different stresses of force on the outer surface from those on the inner. We shall then find that simply through the inversion quite a new form arises. The form may appear thus before we have reversed it (Fig. 1): we turn it inside out and now different forces come into consideration on the red surface and on the white, so that perhaps, purely through the inversion, this form arises (Fig. 3). Such a form might arise merely in the process of inversion. When the red side faced inward, forces remained dominant which are developed differently when it is turned outward. And so with the white side; only when turned towards the inside can it develop its inherent forces.

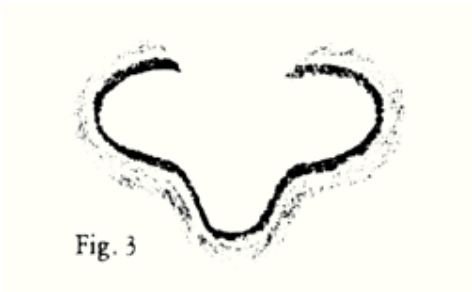
Fig. 3

It is of course quite conceivable to give a mathematical presentation of such a subject, but people are thoroughly disinclined nowadays to apply to reality what is arrived at conceptually in such a way. The moment, however, we learn to apply this to reality, we become able to see in our long bones or tubular bones (that is, in the limb bones), a form which, when inverted, becomes our skull bones! In the drawing, let the inside of the bone, as far as the marrow, be depicted by the red, the outside by the white (Fig. 4). Certain forms and forces, which can of course be investigated, are turned inward, and what we see when we draw away the muscle from the long bone is turned outward. But now imagine

these hollow bones turned inside out by the same principle as I have just given you, in which other conditions of stress and strain are brought into play;

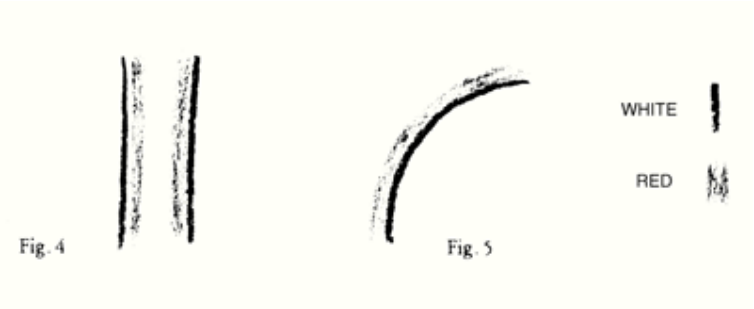

Fig. 4 Fig. 5

then you may easily obtain this form (Fig. 5). Now it has the white within, and what I depicted by the red comes to the outside. This is in fact the relationship of a skull-bone to a limb-bone, and in between lies the typical bone of the back — the vertebra of the spinal column. You must turn the tubular bone inside out like a glove according to its indwelling forces; then you obtain the skull-bone. The metamorphosis of the bones of the limbs into the skull-bones is only to be understood when keeping in mind the process of inversion, or 'turning inside-out'. The important thing to realizes is that what is turned outward in the limb-bones is turned inward in the skull. The skull-bones turn towards a world of their own in the interior of the skull. That is one world. The skull-bone is orientated to the world, just as the limb-bone is orientated outward, towards the external world. This can be clearly seen in the case of the bones. Moreover, the human organism as a whole is so organized that it has on the one hand a skull organization, and on the other a limb-organization, the skull-organization being oriented inward, the limb-organization outward. The skull contains an inner world, the limb-man an outer world, and between the two is a kind of balancing system which preserves the rhythm.

My dear friends, take any literature dealing with the theory of functions, or, say, with non-Euclidean geometry, and see what countless ideas of every kind are brought forward in order to get beyond the ordinary geometrical conception of three-dimensional space; — to extend the domain — widen out the concept of geometry. You will see what industry and ingenuity are employed. But now suppose that you have become an expert at mathematics, who knows the theory of functions well and understands all that can be understood today of non-Euclidean geometry. I should like now to put a question concerning much that tends in this direction (Forgive me if it seems as if one did not value them highly, speaking of these things in such trivial terms. And yet I must do so, and I beg the audience, especially trained mathematicians, to turn it over in their minds and see if there is not truth in what I say.) The question could be put as follows: What is the use of all this spinning of purely mathematical thoughts? What is it work t me, so to speak, in pounds, shillings and pence? No one is interested in the spheres in which it might perhaps find concrete application. Yet if we were to apply to the structure of the human organism all that has been thought out in non-Euclidean geometry, then we should be in the realm of reality, and applying immeasurably important ideas to reality, not wandering about in mere speculations. If the mathematician were so trained as to be interested also in what is real, — in the appearance of the heart, for example, so that he could form an idea of how through a mathematical process he could turn the heart inside out, and how thereby the whole human form would arise, — if he were taught to use his mathematics in actual life, then he could be working in the realm of the real. It would then be impossible to have the trained mathematician on the one hand, not interested in what the doctor learns, and on the other, the physician, understanding nothing of of how the mathematician — though in a purely abstract element — is able to change and metamorphose forms. This is the situation we must alter. If not, our sciences will fall into decay. They grow estranged from one another; people no longer understand each other's language.

How then is science to be transformed into a social science, as is implied in all that I shall be telling you in these lectures? A science which leads over into social science is not yet in existence.

On the one hand we have Astronomy, tending more and more to be clothed in mathematical forms of thought. It has become so great in its present form just because it is a purely mathematical and mechanical science. But there is another branch of science which stands, as it were, at the opposite pole to Astronomy, and which cannot be studied in its real nature without Astronomy. It is however, impossible, as science is today, to build a bridge between Astronomy and this other pole of science, namely, Embryology. He alone is studying reality, who on the one hand studies the starry skies and on the other hand the development of the human embryo. How is the human embryo generally studied today? Well, it is stated: The human embryo arises from the interaction of two cells, the sex-cells or gametes, male and female. These cells develop in the parent organism in such a way as to attain a certain state of independence before they are able to interact. They then present a certain contract, the one cell, the male, calling forth new and different possibilities of development in the other, the female. The question is put: What is a cell? As you know, since about the middle of the 19th century, Biology has largely been built upon the cell theory. The cell is described as a larger or smaller, spherule, consisting of albuminous or protein-like substances. It has a nucleus within it of a somewhat different structure and around the whole is an enclosing membrane. As such, it is the building-stone for all that arising by way of living organisms. The sex-cells are of a similar nature but are formed differently according to whether they are male or female, and from such cells every more complicated organism is built up.

But now, what is actually meant when it is said that an organism builds itself up from these cells? The idea is that substances which are otherwise in Nature are taken up into these cells and then no longer work in quite the same way as before. If oxygen, nitrogen or carbon are contained in the cells, the carbon, for instance, does not have the effect upon some other substance outside, that it would have had before; such power of direct influence s lost to it. It is taken up into the organism of the cell and can only work there as conditions in the cell allow. That is to say, the influence is exerted not so much by the carbon, but by the cell, which makes use of the particular characteristics of carbon, having incorporated a certain amount of it into itself. For example, what man has within him in the form of metal — iron for instance — only works in a circuitous way, via the cell. The cell is the building-stone. So in studying the organism, everything is traced to the cell. Considering at first only the main bulk of the cell, without the nucleus and membrane, we distinguish two parts: a transparent part composed of this fluid, and another part forming sort of framework. Describing it schematically, we may say that there is the framework of the cell, and this is embedded, as it were, in the other substance which, unlike the framework, is quite unformed. (Fig. 6) Thus we must think of the cell

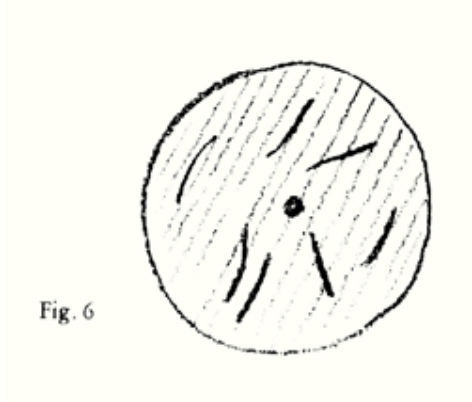

Fig. 6

as consisting of a mass which remains fluid and unformed and a skeleton or framework which takes on a great variety of forms. This then is studied. The method of studying cells in this way has been pretty well perfected; certain parts in the cell can be stained with color, others do not take the stain. Thus with carmine or saffron, or whatever coloring matter is used, we are able to distinguish the form of the cell and can thus acquire certain ideas about its inner structure. We note, for instance, how the inner structure changes when the female germ-cell is fructified. We follow the different stages in which the cell's inner structure alters; how it divides; and how the parts become attached to one

another, cell upon cell, so that the whole becomes a complicated structure. All this is studied. But it occurs to no-one to ask: With what is this whole life in the cell connected? What is really happening? It does not occur to anyone to ask this.

What happens in the cell is to be conceived, my dear friends, in the following way, — though to be sure, it is still a rather abstract way. There is the cell. For the moment let us consider it in its most usual form, namely the spherical form. This spherical form is partially determined by the thin fluid substance, and enclosed within it is the delicate framework. But what is the spherical form? The thin fluid mass is as yet left entirely to itself and therefore behave according to the impulses it receives from its surroundings. What does it do? Well, my dear friends, it mirrors the universe around it! It takes on the form of the sphere because it mirrors in miniature the whole cosmos, which we indeed also picture to ourselves ideally as a sphere. Every cell in its spherical form is no less than an image of the form of the whole universe. And the framework inside, every line of the form, is conditioned by its relationship to the structure of the whole cosmos. To express myself abstractly to begin with, think of the sphere of the universe with its imaginary boundary (Fig. 7). In it, you have here a planet, and there a planet (a,a1). They work in such a way as to exert an influence upon one another in the direction of the line which joins them. Here (m) let us say — diagrammatically, of course, — a cell is formed; its outline mirrors the sphere. Here, within the framework it has a solid part which is due to the working of the one planet on the other. And suppose that here there were another constellation of planets, working upon each other along the line joining them (b,b1).

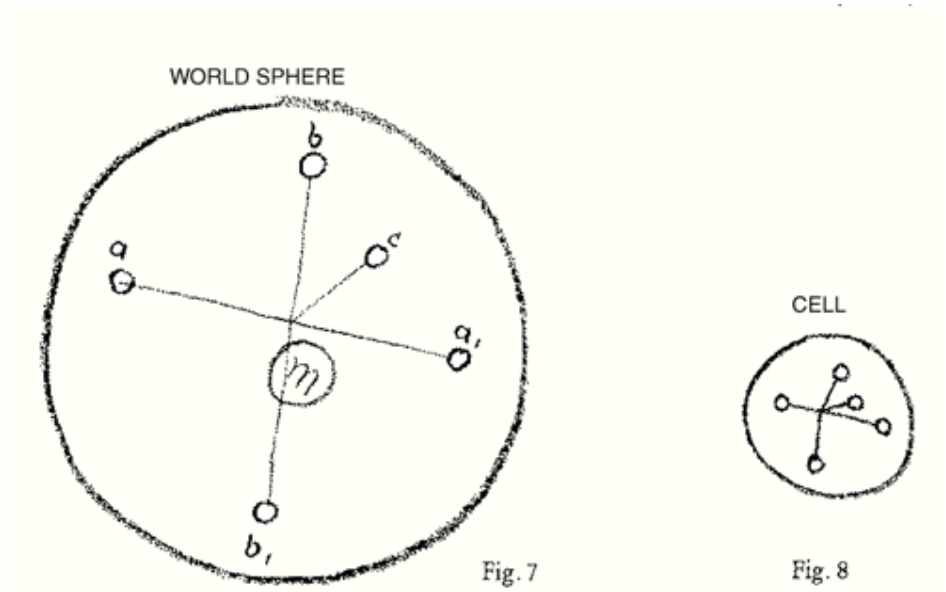

Fig. 7 Fig. 8

And here again there might be yet another planet (c), this one having no counterpart; — it throws the whole construction, which might otherwise have been rectangular, out of shape, and the structure takes on a somewhat different form. And so you have in the whole formation of the framework of the cell a reflection of the relationships existing in the planetary system, — altogether in the whole starry system. You can enter quite concretely into the formation of the cell and you will reach an understanding of this concrete form only if you see in the cell an image of the entire cosmos.

And now take the female ovum, and picture to yourselves that this ovum has brought the cosmic forces to a certain inner balance. They have taken on form in the framework of the cell, and are in a certain way at rest within it, supported by the female organism as a whole. Then comes the influence of the male sex-cell. This has not brought the macrocosmic forces to rest, but works in the sense of a very specialized force. It is as though the male sex-cell works precisely along this line of force (indicated by Dr. Steiner on the blackboard) upon the female ovum which has come to a condition of

rest. The cell, which is an image of the whole cosmos, is thereby caused to relinquish its microcosmic form once more to a changing play of forces. At first, in the female ovum, the macrocosm comes to rest in a peaceful image. Then through the male sex-cell the female is torn out of this state of rest, and is drawn again into a region of specialized activity and brought into movement. Previously it had drawn itself together in the resting form of the image of the cosmos, but the form is drawn into movement again by the male forces which are, so to speak, images of movement. Through them the female forces, which are images of the form of the cosmos and have come to rest, are brought out of this state of rest and balance.

Here we may have some idea, from the aspect of Astronomy, of the forming and shaping of something which is minute and cellular. Embryology cannot be studied at all without Astronomy, for what Embryology has to show is only the other pole of what is seen in Astronomy. We must, in a way, follow the starry heavens on the one hand, seeing how they reveal successive stages, and we must then follow the process of development of a fructified cell. The to belong together, for the one is only the image of the other. if you understand nothing of Astronomy, you will never understand the forces which are at work in Embryology, and if you understand nothing of Embryology, you will never understand the meaning of the activities which Astronomy has to deal. For these activities appear in miniature in the processes of Embryology.

It is conceivable that a science should be formed, in which, on the one hand, astronomical events are calculated and described, and on the other hand all that belongs to them in Embryology, which is only the other aspect of the same thing.

Now look at the position as it is today: you find that Embryology is studied on its own. It would be regarded as madness if you were to demand of a modern embryologist that he should study Astronomy in order to understand the phenomena in his own sphere of work. And yet it should be so. This is why a complete regrouping of the sciences is necessary. It will be impossible to become a real embryologist without studying Astronomy. It will no longer be possible to educate specialists who merely turn their eyes and their telescopes to the stars, for to study the stars in that way has no further meaning unless one knows that it is out of the great universe that the minute and microscopical is fashioned.

All this, — which is quite real and concrete, — has in scientific circles been changed into the utmost abstraction. It is reality to say: We must strive for astronomical knowledge in cellular theory, especially in Embryology. If DuBois-Raymond has said that the detailed astronomical facts should be applied to the cell-theory, he would have spoken out of the sphere of reality. But what he wanted corresponds to no reality, namely that something thought-out and devised — the atoms and molecules — should be examined with astronomical precision. He wanted the astronomical type of mathematical thoughts, which have been added to the world of the stars, to be sought for again in the molecule.

Thus you see, upon the one hand lies reality: movement, the active forces of the stars and the embryonic development in which there lives, in all reality, what lives in the starry heavens. That is where the reality lies and that is where we must look for it. On the other hand lies abstraction. The mathematician, the mechanist, calculates the movements and forces of the heavenly bodies and then invents the molecular structure to which to apply this kind of astronomical knowledge. Here he is withdrawn from life, living in pure abstractions.

These are the things about which we must think, remembering that now we must renew, in full consciousness, something which was in a certain sense present in earlier times. Looking back to the Egyptian Mysteries, we find astronomical observations such as were made at that time. These observations, my dear friends, were not used merely to calculate when an eclipse of the Sun or Moon would take place, but rather to arrive at what should come about in social evolution. Men were guided by what they saw in the heavens, as to what must be said to the people, what instructions should be given, so that the development of the whole social life should take its right course. Astronomy and Sociology were dealt with as one. We too, though in a different way from the Egyptians, must again

learn how to connect what happens in social life with the phenomena of the great universe. We do not understand what came about in the middle of the 15th century, if we cannot relate the events of that time to the phenomena which then prevailed in the universe. It is like a blind man talking about color to speak of the changes in the civilized world in the middle of the 15th century without taking all this into account.

Spiritual Science is already a starting point. But we shall not succeed in bring together the complicated domain of Sociology — social science — with the observations of natural phenomena, unless we first begin by connecting Astronomy with Embryology, linking the embryonic facts with astronomical phenomena.

Lecture II
Stuttgart, January 2, 1921

My Dear Friends,

Yesterday I showed a connection between two branches of science which according to our modern ideas are widely separated. I sought to show that the science of Astronomy should provide certain items of knowledge which must then be turned to account in quite a different branch of science, from which the study and method of Astronomy is completely excluded nowadays. In effect, I sought to show that Astronomy must be linked with Embryology. It is impossible to understand the phenomena of cell-development, especially of the sex-cells, without calling to our aid the realities of Astronomy, which lie apparently so far removed from Embryology.

I pointed out that there must come about a regrouping of the sciences, for a man specializing nowadays along certain lines finds himself hemmed in by the circumscribed divisions of science. He has no possibility of applying his specialized knowledge and experience to spheres which may lie near to hand but which will only have been presented to him from certain aspects, insufficient to give him a deeper understanding of their full significance. If it is true, as will emerge in these lectures, that we can only understand the successive stages in human embryonic development when we understand their counterpart, the phenomena of the Heavens; if this is a fact — and it will turn out to be so — then we cannot work at Embryology without working at Astronomy. Nor can we occupy ourselves with Astronomy without bringing new light to the facts of Embryology. In Astronomy we are studying something which reveals its most important activity in the development of the human embryo. How, then, shall we explain the meaning and reason of astronomical facts, if we bring into the kind of connection with these facts the very realm in which this meaning and reason are revealed?

You see how necessary it is to come to a reasonable world-conception, out of the chaos in which we are today in the sphere of science. If, however, one only accepts what is fashionable nowadays, it will be very difficult to grasp, even as a general idea, anything like what I said yesterday. For the evolution of our time has brought it about that astronomical facts are only grasped through mathematics and mechanics, while embryological facts are recorded in such a way that in dealing with them anything of the nature of mathematics or mechanics is discarded. At most, even if the mathematical-mechanical is brought into some kind of relation to Embryology, it is done in a quite an external way, without considering where lies the origin of what, in embryonic development, might truly be expressed in mathematical and mechanical terms.

Now I need only point to a saying of Goethe's, uttered out of a certain feeling — a ‘feeling knowledge’ I might call it — but indicating something of extraordinary significance. (You can read of it in Goethe's “Spruche in Prosa”, and in the Commentary which I added to the publication in the Kurschner edition of the Deutsche National-Literatur, where I spoke in detail about this passage.) Goethe says there: People think of natural phenomena so entirely apart from man that they are tending ever more and more to disregard the human being in their study of the phenomena of Nature. He, on the contrary, believed that natural phenomena only reveal their true meaning if they are regarded in full connection with man — with the whole organization of man. In saying this, Goethe pointed to a method of research which is well-nigh anathematized nowadays. People today seek an 'objective' understanding of Nature through research that is completely separated from the human being. This is particularly noticeable in such a science as Astronomy, where no account at all is taken of the human being. On the contrary, people are proud that the apparently ‘objective’ facts have shown that man is only a grain of dust upon an Earth which has somehow been fused into a planet, moving first round the Sun and then, in some way or other, moving with the Sun in space. They are proud that one need pay no attention to this ‘grain of dust’ which wanders about on Earth, — that one need only pay attention to what is external to the human being in considering the great celestial phenomena.

Now the question is, whether any real results are to be obtained by such a method.

I should like once more to call attention, my dear friends, to the path we must pursue in these lectures. What you will find as proof will only emerge in the further course of the lectures. Today we must take a good deal simply from observation in order to form certain preliminary ideas. We must first build up certain necessary concepts; only then shall we be able to pass on to the verification of these concepts.

From what source, then, can we gain a real perception of the celestial phenomena merely through the mathematics which we apply to them? The course of development of human knowledge can disclose — if one does not take up the proud position of thinking how 'wonderfully advanced' we are today and how all that went before was childish — the course of human development can teach us how the prevailing points of view can change.

From certain aspects one can have great reverence for the celestial observations carried out, for instance, by the ancient Chaldeans. The ancient Chaldeans made very exact observations concerning the connection of human time-reckoning with the heavenly phenomena. They had a highly develop 'Calendar-Science'. Much that appears to us today as self-evident really dates back to the Chaldeans. Yet the Chaldeans were satisfied with a mathematical picture of the Heavens which portrayed the Earth more or less as a flat disc, with the hollow hemisphere of the heavenly vault arched above, the fixed stars fastened to it, and the planets moving over it. (Among the planets they also included the Sun.) They made their calculations with this picture in the background. Their calculations for the most part were correct, in spite of being based upon a picture which the science of today can only describe as a fundamental error, as something 'childish'.

Science, or more correctly, the scientific tendency and direction, then went on evolving. There was a stage when men pictured that the Earth stood still, but that Venus and Mercury moved round the Sun. The Sun formed the central point, as it were, for the motions of Venus and Mercury, while the other planets — Mars, Jupiter and Saturn — moved round the Earth. Thereafter, men progressed to making Mars, Jupiter and Saturn also revolved around the Sun, but the Earth was still supposed to stand still, while the Sun with its encircling planets as well as the starry Heavens revolved round the Earth. This was still the fundamental view of Tycho Brahe, whereas his contemporary Copernicus established the other concept, namely, that the Sun was to be regarded as standing still and that the Earth was to be reckoned among the planets revolving round the Sun. Following hard one upon the other in the time of Copernicus were the two points of view, one which existed in ancient Egypt, of the stationary Earth with the other planets encircling the Sun, still represented by Tycho Brahe; the other, the Copernican concept, which broke radically with the idea of the center of coordinates being in the center of the Earth, and transferred it to the center of the Sun. For in reality the whole alteration made by Copernicus was nothing else than this, — the origin of coordinates was removed from the center of the Earth to the center of the Sun.

What was actually the problem of Copernicus? His problem was, how to reduce to simple lines and curves these complicated apparent motions of the planets, — ; for so they appear as observed from the Earth. When the planets are observed from the Earth, their movements can only be described as a variety of looped lines, such as these (Fig. 1). So, when taking the center of the Earth as the center of coordinates it is necessary to base the planetary movements on all sorts of complicated curves. Copernicus said, in effect: 'as an experiment, I will place the center of the whole coordinate system in the center of the Sun.' Then the complicated planetary curves are reduced to simple circular movements, or as was stated later, to ellipses. The whole thing was purely the construction of a world-system which aimed at being able to represent the paths of the planets in the simplest possible curves.

Figure 1

Now today we have a very remarkable fact, my dear friends. This Copernican system, when employed purely mathematically, supplies the necessary calculations concerning the observed phenomena as well as and no better than any of the earlier ones. The eclipses of the Sun and Moon can be calculated with the ancient Chaldean system, with the Egyptian, with the Tychonian and with the Copernican. The outer occurrences in the Heavens, in so far as they relate to mechanics or mathematics, can thus be foretold. One system is as well suited as another. It is only that the simplest thought-pictures arise with the Copernican system. But the strange thing is that in practical Astronomy, calculations are not made with the Copernican system. Curiously enough, in practical Astronomy, — to obtain what is needed for the calendar, — the system of Tycho Brahe is used! This shows how little that is really fundamental, how little of the essential nature of things, comes into question when the Universe is thus pictured in purely mathematical curves or in terms of mechanical forces.

Now there is another very remarkable fact which I will only indicate today, so that we shall understand each other about the aim of these lectures. I shall speak further about it in succeeding lectures. Copernicus in his deliberations bases his cosmic system upon three axioms. The first is that the Earth rotates on its own North-South axis in 24 hours. The second principle on which Copernicus bases his picture of the Heavens is that the Earth moves round the Sun. In its revolution round the Sun the Earth itself, of course, also revolves in a certain way. This rotation, however, does not occur round the North-South axis of the Earth, which always points to the North Pole, but round the axis of the Ecliptic, which, as we know, is at an angle with the Earth's own axis. Therefore the Earth goes through a rotation during a 24-hour day round its own N. S. Axis, and then, inasmuch as it performs approximately 365 such rotations in the year, there is added another rotation, an annual rotation, if we disregard the revolution round the Sun. The Earth, then, if it always rotates thus, and then again revolves round the Sun, behaves like the Moon as it rotates round the Earth, always turning the same side towards us. The Earth does this too, inasmuch as it revolves round the Sun, but no on the same axis as the one on which it rotates for the daily revolution. It revolves through this 'yearly day' on another axis; this is an added movement, besides the one taking place in the 24-hour day.

Copernicus' third principle is that not only does such a revolution of the Earth take place round the North-South axis, but that there is yet a third revolution which appears as a retrograde movement of the North-South axis round the axis of the Ecliptic. Thereby, in a certain sense, the revolution round the axis of the Ecliptic is canceled out. By reason of this third revolution the Earth's axis continuously points to the North celestial Pole (the Pole-Star). Whereas, by virtue of revolving round the Sun, the Earth's axis would have to describe a circle, or an ellipse, round the pole of the Ecliptic, its own revolution, which takes the opposite direction (every time the Earth proceeds a little further its axis rotates backwards), causes it to point continually to the North Pole. Copernicus adopted this third principle, namely: The continued pointing of the Earth's axis to the Pole comes about because, by a rotation of its own — a kind of ‘inclination’ (?) — it cancels out the other revolution. This latter therefore has no effect in the course of the year, for it is constantly being annulled.

In modern Astronomy, founded as it is on the Copernican system, it has come about that the first two axioms are accepted and the third is ignored. This third axiom is lightly brushed aside by saying that the stars are so far away that the Earth-axis, remaining parallel to itself, always points practically to the same spot. Thus it is assumed that the North-South axis of the Earth, in its revolution, remains

always parallel to itself. This was not assumed by Copernicus; on the contrary, he assumed a perpetual revolving of the Earth's axis. Modern Astronomy is therefore not really based on the Copernican system, but accepts the first two axioms because they are convenient and discards the third, thus becoming lost in the prevarication that it is not necessary to suppose that the Earth's axis itself must move in order to keep pointing to the same spot in the Heavens, but that the place itself is so far away that even if the axis does move parallel to itself it will still point to the same spot. Anyone can see that this is a prevarication. To-day therefore we have a 'Copernican system' from which a most important element has actually been discarded.

The development of modern Astronomy is presented in such a way that no one notices that an important element is missing. Yet only in this way is it possible to describe it all so neatly: "Here is the Sun the Earth goes round in an ellipse with the Sun in one of the foci." (Fig. 2)

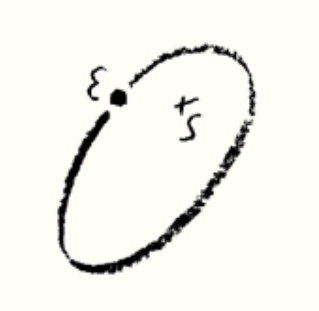

Fig. 2

As time went on it became no longer possible to hold to the starting-point of the Copernican theory, namely that the Sun stands still. A movement is now attributed to the Sun, which is said to move forward with the whole ellipse, perpetually creating new ellipses, so to speak (Fig. 3). It became necessary to introduce the Sun's own movement, and this was done simply by adding something new to the picture they had before. A mathematical description is thus obtained which is admittedly convenient, but few questions are asked as to its possibility or its reality. It is only from the apparent movement of the starts that the Earth's movement is deduced by this method. As we shall presently see, it is of great significance whether or no one assumes a movement — which indeed must be assumed — namely the aforesaid 'inclination' (?) of the Earth's axis, perpetually annulling the annual rotation. Resultant movements, after all, are obtained by adding up the several movements. If one is left out, the whole is no longer true. Thus the whole theory that the Earth moves round the Sun in an ellipse comes into question.

Fig. 3

You see, purely from these historical facts, that burning questions exist in Astronomy today, though it is seemingly a most exact science because it is mathematical. The question arises: Why do we live in such uncertainty with regard to a real astronomical science? We must then ask further, turning the question in another direction: Can we reach any real certainty through a purely mathematical approach? Only think that in considering a thing mathematically we lift the observation out of the

sphere of external reality. Mathematics is something that ascends from our inner being; in mathematics we lift ourselves out of external reality. It must therefore be understood from the outset that if we approach an external reality with a method of investigation that lifts itself out of reality, we can, in all probability, only arrive at something relative.

To begin with, I am merely putting forward certain general considerations. We shall soon come to the realities. The point is that in regarding things purely from the mathematical standpoint, man does not put reality into his though with sufficient energy, in order to approach the phenomena of the outer world rightly. This, indeed, demands that the celestial phenomena be brought nearer to man; they must not be regarded as quite apart from man, but must be brought into relationship with man. It was only one particular instance of this associating of the heavenly phenomena with the human being, when I said that we must see what takes place out there in the starry world in its reflection in the embryonic process. But let us look at the matter at first somewhat more generally. Let us ask whether we cannot perhaps find another approach to the celestial phenomena than the purely mathematical one.

We can indeed bring the celestial phenomena, in their connection with earthly life, somewhat nearer to man in a purely qualitative way. We will not disdain to form a basis today with seemingly elementary ideas, these ideas being just the ones that are excluded from the foundations of modern Astronomy. We will ask the following question: How does man's life on Earth appear, in relation to Astronomy? We can regard the external phenomena surrounding man from three different points of view. We can regard them from the standpoint of what I will call the solar life, the life of the Sun; the lunar life; and the terrestrial, the tellurian life.

Let us think first in quite a popular, even elementary way how these three domains play around man and upon him. Clearly there is something on the Earth which is in complete dependence upon the Sun-life, including also that aspect of the Sun's life which we shall have to look for in the Sun's movement of state of rest, and son on. We will leave aside the quantitative aspect and today merely consider the qualitative. Let us try to be clear as to how, for instance, the vegetation of any given region depends upon the solar life. Here we need only call to mind what is very well known with regard to vegetation, namely, the difference in the vegetation of spring, summer, autumn and winter; we shall be able to say that we see in the vegetation itself an imprint of the solar life. The Earth opens herself in a given region to what is outside her in heavenly space, and this reveals itself in the unfolding of vegetative life. If the Earth closes herself again to the solar life, the vegetation recedes.

There is, however, an interplay of activity between the terrestrial or tellurian and the solar life. There is a difference in the solar life according the the variation of tellurian conditions. We must here bring together quite elementary facts and you will see how they lead us further. Take, for example, Egypt and Peru, two regions in the tropical zone. — Egypt, a low-lying plain, Peru a table land, and compare the vegetation. You will see how the tellurian element, simply the distance from the center of the Earth in this instance, plays its part in conjunction with the solar life. You only need study the vegetation over the earth, regarding the Earth, not as mere mineral but as incorporating plant-nature as well, and in the picture of vegetation you have a starting-point for an understanding of the connection of the earthly with the celestial. But we perceive the connection most particularly when we turn our attention to mankind.

We have, in the first place, two opposites on the Earth: the Polar and the Tropical. The Polar and the tropical form a polarity, and the result of this polarity shows itself very clearly in human life.

Is it not so that life in the polar regions brings forth in man a condition of mind and spirit which is more or less a state of apathy: The sharp contrast of a long winter and a long summer which are almost like one long day and one long night, produces a certain apathy in man; it is as though the setting in which man lives makes him apathetic. In the Tropics, man also lives in a region which makes him apathetic. But the apathy of the polar region is based upon a sparse external vegetation — sparse and meager in a peculiar way even where it develops to some extent. The tropical apathy of man is caused by a rich, luxuriant vegetation. Putting together these two pictures of environment one can say that the

apathy which affects man in polar regions is different from that affecting him in tropical regions. He is apathetic in both regions, but the apathy results from different causes. In the Temperate Zone lies the balance. Here the human capacities are developed in a certain equilibrium.

No-one will doubt that this has something to do with the solar life. But what is the connection: (I will, as I said, first make a few remarks based on observation and in this way arrive at essential concepts.) Going to the root of things, we find that in the life around the Poles there is a very strong working-in of the Sun-forces upon man. In those regions the Earth tends to withdraw from the life of the Sun; she does not let her activity shoot upward from below into the vegetation. But the human being is exposed in these parts to the true Sun-life (you must not only look for the Sun-life in mere warmth). That this is so, the vegetation itself bears witness.

We have, then, a preponderance of solar influence in the Polar zones. what kind of life predominates in the Tropical? There it is the tellurian, the Earth-life. This shoots up into the vegetation, making it rich and luxuriant. This also robs man of a balanced development of his capacities, but the causes in the North and in the Tropics come from different directions. In Polar regions the sunlight represses man's inner development. In the Tropics, what shoots up from the Earth represses his inner powers. We thus see a certain polarity, the polarity shown in the preponderance of the Sun-life around the Poles, and of the tellurian life in tropical regions — ;in the neighborhood of the Equator.

If we then observe man and have in mind the human form, we can say the following. (Please do not object at once if it seems paradoxical, but wait a little. We shall be taking the human form seriously.) The head, the part of the human form which in its outer configuration copies universal space, — namely the sphere, the spherical shape of the Universe as a whole — the head is exposed by life in polar regions to what comes from the Cosmos outside the Earth. In the Tropics, the metabolic system in its connection with the limbs is exposed to the Earth-life as such.

We come to a special relationship, you see, of the human head to the cosmic life outside the Earth and of the human metabolic and limb-system to the Earth-life. Man is so placed in the Universe as to be more co-ordinated with the cosmic surroundings of the Earth in his head, his nerve-senses system, and with the Earth-life in his metabolic system. And in the temperate zones we shall have to look for a kind of perpetual harmonizing between the head-system and the metabolic system. In the temperate zones there is a primary development of the rhythmic system in man.

You see then that there exists a certain connection between this threefold membering of man — nerves-and-senses system, rhythmic system, metabolic system — and the outer world. The head-system is more related to the whole Cosmos, the rhythmic system is the balance between the Cosmos and the earthly world, and the metabolic system is related to the earth itself. Then we must take up another indication, which points to a working of the solar life upon mankind in a different direction.

The connection of the solar life with the life of man which we have just been considering can only be related to the interplay of the earthly and extra-earthly life in the course of the year. But as a matter of fact, in the course of the day we are also concerned with a kind of repetition, even as in the yearly course. The yearly course is determined by the relation of the Sun to the Earth, and so is the daily course. In the language of purely mathematical astronomy we speak of the daily rotation of the Earth on its axis, and of the revolution of the Earth round the Sun in the course of the year. But we are then confining ourselves to very simple aspects. We have then no justification for assuming that we are really starting from adequate premisses, giving an adequate basis for our investigations. Let us call to mind all that we have considered with regard to the yearly course. I will not say ‘the revolution of the Earth round the Sun’, but the course of the year with its alternating conditions. This must have a connection with the three-fold being of man. Since through the earthly conditions it finds different expression in the Tropics, in the Temperate Zones and at the Poles, this yearly course must be connected in some way with the whole formation of man — with the relations of the three members of the threefold man. When we bring this into consideration, we acquire a wider basis from which to

proceed and can perhaps arrive at something quite different from what we reach when we merely measure the angles which one telescopic direction makes with another. It is a matter of finding broader foundations in order to be able to judge the facts.

Speaking of the daily course, we speak in the astronomical sense of the rotation of the Earth on its axis. But something rather different is here revealed. There is revealed a far-reaching independence of man upon this daily course. The dependence of man on the yearly rhythm, namely on what is connected with the yearly course, the shaping of the human form in the various regions of the Earth, shows us a very great dependence of man on the solar life, — on the changes that appear on Earth in consequence of the solar life. The daily course shows it far less. True, very much of interest will also be revealed in connection with the daily course, but as regards the life of mankind as a whole it is relatively insignificant. The differences appear in individual human beings. Goethe, who can be regarded in a certain respect as a normal type of man, felt himself best attuned to production in the morning; Schiller at night. This points to the fact that the daily rhythm has a definite influence upon certain subtler parts of human nature. A man who has a feeling for such things,will tell us that he has met many persons in his life who have confided to him that their really important thoughts were worked out in the dusk, that is, in the temperate period of the day-to-day rhythm, not at midday nor at midnight, but in the temperate time of.the day. It is however, a fact that man is in a way independent of the daily course of the Sun. We have still to go into the significance of this independence and to show in what way a certain dependence does nevertheless exist.

A second element is the lunar life, the life that is connected with the Moon. It may be that a great deal of what has been said on this subject in the course of human evolution appears today as mere fantastic nonsense. But in one way or another we see that the Earth-life as such, for example in the phenomena of tidal ebb and flow, is connected quite evidently with the movement of the Moon. Nor must it be overlooked that the female functions, although they do not coincide in time with the Moon's phases, coincide with them in their periodicity, and that therefore something essentially concerned with human evolution is shown to be dependent in time and duration upon the phases of the Moon. It is as though this process of the female function were lifted out of the general course of Nature, but has remained a true image of Nature's process; it is accomplished in the same period of time as the corresponding natural phenomenon.

Just as little must it be overlooked — only people do not make rational, exact observations of these things if they turn aside from them at the very outset — just as little must it be overlooked that as a matter of fact, man's life of fancy and imagination is extraordinarily bound up with the phases of the Moon. If anyone were to keep a calendar-record of the upward and downward flow of his life of imagination, he would notice how much it had to do with the Moon's phases. The fact that the Moon-life, the lunar life, has an influence upon certain lower organs should he studied in the phenomenon of the sleep-walker. In the sleep-walker, interesting phenomena can be studied; phenomena which are overlaid by normal human life, but are present in the depths of human nature and point in their totality to the fact that the lunar life is just as much connected with the rhythmic system of man as is the solar life with his nerves-and-senses system.

This gives a sort of crossing of influences. We have seen how the solar life, in its interplay with the forces of the Earth, works on the rhythmic system in the temperate zones. Crossing this influence, we now have the direct influence of the lunar life upon the rhythmic system.

When we now look at the tellurian, the Earth-life as such, we must not disregard a domain in which the earthly influence makes itself felt; though, to be sure, this is not ordinarily taken into account. I ask you to turn your attention to such as phenomenon as home-sickness. It is difficult to from any clear ideas about home-sickness. It can no doubt be explained from the point of view of habit, custom, and so on. But I ask you to note that real physiological effects can be produced entirely as a result of this so-called home-sickness. Home-sickness can go so far as to make a man ill. It can express itself in such phenomena as asthma. Study the complex of the phenomena of home-sickness with its consequences, asthmatic conditions and general ill-health, a kind of emaciation, and it s possible to

come to the following conclusion. One comes to see that ultimately the feeling of home-sickness results from an alteration of the metabolism — the whole metabolic system. Home-sickness is the reflection in consciousness of changes in the metabolism — changes entirely due to the man's removal from one place, with its tellurian influences from below, to another place, with different influences coming from below. Please take this in connection with other things which, unfortunately, Science as a rule leaves unconsidered.

Goethe, I said, felt most inspired to poetry, to the writing of his works in the morning. If he needed a stimulant however, he took that stimulant which in its nature takes least hold of the metabolic system, but only stirs it up via the rhythmic system, namely wine. Goethe took wine as a stimulant. In this respect he was, indeed, altogether a Sun-man; he let the influence of the solar life work upon him. With Schiller or Byron this was reversed. Schiller preferred to write his poetry when the Sun has set, that is to say when the solar life was hardly active any more. And he stimulated himself with something which takes thorough hold of the metabolic system — with hot punch. The effect was quite different from that obtained by Goethe from wine. It worked into the whole metabolism. Through the metabolism the Earth works upon man; so we can say that Schiller was essentially tellurian — an Earth-man. Earth-men work more through the emotions and what belongs to the will; the Sun-man works rather through calm and contemplation. For those persons, therefore, who could not endure the solar element, but only liked the tellurian, only what is of the Earth Goethe increasingly became “the cold literary Greybeard” as they called him in Weimar — “the cold, literary greybeard with the double chin.” That was the name which was so often given to Goethe in Weimar in the 19th century.

Now I should like to bring something rather different to your notice. We have observed how man is set into the universal connections of Earth, Sun, Moon: the Sun working more on the nerves-and-senses system; the Moon working more on the rhythmic system; the Earth, inasmuch as she gives man of her substance as nourishment and makes substance directly active in him, working upon the metabolic system, working tellurically. We see something in man through which we can perhaps find starting-point for an explanation of the Heavens as they exist outside man, upon broader foundations than merely through the measurement of angles by the telescope and so on.

This is especially so if we go yet further, if we now consider Nature outside of man, — but consider it so as to see more in it than a mere register of external data. Look at the metamorphosis of insects. In the course of the year it is a complete reflection of the external solar life. I would say that with man we must make our researches more in the inner being in order to follow what is solar, lunar and tellurain in him, whereas in the insect-life with its metamorphoses, we see the direct course of the year expressed in the successive forms the insect assumes. We can now say to ourselves: Maybe we have not to only proceed quantitatively, but should also take into account the qualitative impression which such phenomena make upon us Why always merely ask what a phenomenon of the outer Universe looks like in the objective of the telescope? Why not ask what relation is given, not merely by the objective of the telescope, but by the insect? How does human nature react? Is anything revealed to us through human nature regarding the celestial phenomena? Are we not led in this way to broader foundations, making it impossible that on the one hand, theoretically, we should be Copernicans when desiring to explain the world philosophically, while on the other we use Tychonic System as our basis for calculating the calendar etc., as practical Astronomy still does to this day. Or that we are Copernicans, but set aside the most important part of his theory, namely his third axiom Can we not overcome the uncertainties which create burning problems even in the most fundamental realms of Astronomy today, by working on a broader basis — working in this sphere too from the quantitative to the qualitative?

Yesterday I sought to point out the connection of the celestial with the embryonic phenomena; today, the connection with fully developed man. Here you have an indication towards a necessary regrouping of the sciences. Now take another thing to which I have also referred to in the course of today's remarks. I indicated the connection of human metabolism with the Earth-life. In man we have the faculties of sense-perception mediated through the nerves-and-senses system, connected as a whole with the solar and cosmic life. We have the rhythmic system connected with what lies between

Heaven and Earth. We have the metabolism related especially to the Earth, so that in contemplating metabolic man we should be able to get nearer to the real essence of the tellurian. But what do we do today if we want to approach the tellurian realm? We behave as we habitually do, and investigate things from the outside. But things have an inner side also! Will they perhaps only show it in its true form when they pass through the human being?

It has become and ideal nowadays to regard the relationship of substances quite apart from man and to rest there; to be observe by experimentation in chemical laboratories the reciprocal action of substances in order to arrive at their nature. But if the substances only disclosed their nature within the human being, then we should have to practice Chemistry in such a way as to reach man. Then we should have to form a connection between true Chemistry and the processes undergone by matter within man, just as we see a connection between Astronomy and Embryology, or between Astronomy and the whole human form — the threefold being of man. Thus do the things work into one another. We only come to real life when we perceive them in their interpenetration.

On the other hand, inasmuch as the Earth is poised in cosmic space, we shall have to see the connection between the tellurian and the starry realm.

Now we have seen a connection between Astronomy and the substances of Earth; also between the Earth and human metabolism; and again a direct influence of the solar and celestial events upon man himself. In man we have a kind of meeting of what comes directly from the Heavens and what comes via earthly substance. Earthly substances work on the human metabolism, while the celestial influences work directly upon man as a whole. In man there meet the direct influences for which we are indebted to the solar life, and those influences which, passing indirectly through the Earth, have undergone a change by reason of the Earth. Thus we can say: The interior of the human being will become explicable even in a physical, anatomical sense as a resultant of cosmic influences coming directly from t he Universe outside the Earth, and cosmic influences which have first passed through the earthly process. These flow together in man (Fig. 4).

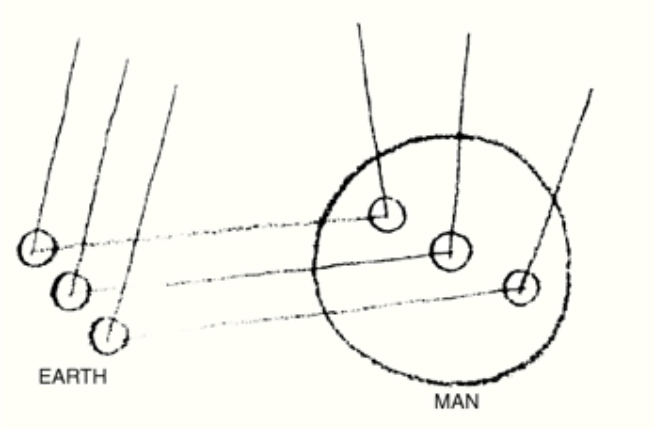

Figure 4

You see how, contemplating man in his totality, the whole Universe comes together. For a true knowledge of man, it is essential to perceive this.

What then has come about by scientific specialization? It has led us away from reality into a purely abstract sphere. In spite of its 'exactness', Astronomy — to calculate the calendar — cannot help using in practice something other than it stands for in theory. And then again, Copernican though it is in theory, it discards what was of great importance to Copernicus, namely the third axiom. Uncertainty creeps in at every point. These modern lines of research do not lead to what matters most of all, — to perceive *how Man is formed from the entire Universe*.

Lecture III
Stuttgart, January 3, 1921

My Dear Friends,

I have brought to your notice on the one hand how problematical it is to conceive the celestial phenomena in their mathematical and geometrical aspect alone. This is now being recognized by many people and from diverse angles. Only quite unadvanced thinkers still maintain that the world-picture of Copernicus and Galileo represents downright reality. Increasingly, we hear the voice of those who find this way of thinking of the celestial phenomena useful and practical, no doubt, for purposes of calculation, yet emphasize that it represents only a certain mode of understanding, and that quite other syntheses might be conceived.

There are even those who say, somewhat as Ernst Mach used to say: In the last resort, one can uphold the Ptolemaic just as well as the Copernican world-system, and a third system might equally well be devised. These are but practical ways of correlating the observed facts. The entire realm should now be confronted with a far freer kind of outlook.

You see from this that the problematical nature of the celestial charts, described but a short time ago as replicas of the real facts, is now conceded by the widest circles. On the other hand an escape from the manifest problems and uncertainties of this realm can only be found through such views as were brought forward in outline yesterday, — views which no longer remove Man from the whole cosmic background, but on the contrary, put him into it from the outset. We have to recognize the processes within Man himself in their connection with solar phenomena, lunar phenomena and terrestrial phenomena, thus taking as a starting-point all that goes on in Man, in order to find the way to what is going on out there in the Cosmos, the latter being in some sense the cause of the processes in Man.

A path like this can of course only be trodden from the standpoint of Spiritual Science. Precisely when we try to bring Astronomy into connection with the most varied spheres of life, we shall find that we are being led through Astronomy itself into the views of Spiritual Science. Bear in mind that the visible celestial phenomena, perceptible to our senses and also to our re-inforced senses, appear at first a manifestation of something outside of man. Man confronts and, as it were, arrests with his senses whatever approaches him, introducing it into his conscious world-picture. But the impulses streaming towards us from all sides, certainly do not come to a standstill before our senses. All that goes on without being held up by man's senses and brought into consciousness, all that lives in the celestial influences that stream towards us from all sides, must be sought for within our bodily organism. The organism must in a certain way reflect it all, and it does this in the unconscious and subconscious processes which can only be raised into consciousness in more complicated ways.

We will now continue in a certain direction what we began yesterday. Only an abstraction of our earthly world is dealt with in Geology or Mineralogy; the Earth as described by Geology consists of minerals has evolved in the mineral sphere; true as it is that forces are there in the Earth by virtue of which it brings forth the minerals; yet is is equally true that all that is living in plants, animals and physical human beings also belongs to the Earth. We only see the Earth in its totality when we do not simply cast aside what lives in plant, animal and man and have in mind the mere abstraction "mineral earth ", but bring it all into our consciousness. The living beings and entities that grow up out of the Earth are also part and parcel of the whole.

Of all that belongs in this way to the Earth, let us first take the plant kingdom. We will approach it in order then to find the transition to what meets us in man. Whereas the mineral kingdom to a certain extent carries on an independent Earth-existence and is only related to the Cosmos outside the Earth in such a way as is shown, for example, in the changing of water into ice in winter, the plant kingdom retains a much greater inner connection with the cosmic surroundings of the Earth — with all that enters the Earth from the Cosmos. Through the plant-world the life of the Earth as it were opens itself

to the Universe. In geographical regions where in a given season an intensive interaction is taking place between Earth and Cosmos. We must pay heed to a phenomenon like this, for it will lead us into the realm of Astronomy not only quantitatively, but qualitatively. We must be able to derive our ideas from such a thing as this, even as the astronomers of our time derive their ideas from angles, parallaxes and so on.

Then we shall say to ourselves, for example: — The plant-life, covering a given region of the Earth, is a kind of sense-organ, sensitive to all that is revealed towards the Earth out of the Cosmos. At seasons when the interplay is more intense between a portion of the Earth's surface and the Universe, it is as though a human being were opening his eyes to the outer world to receive sense-impressions. And when the interplay is less intense between the Earth and the Cosmos, the consequent decline and inward closure of the vegetative life is like a closing of the eyes to the Cosmos. It is more than a mere comparison to say that through its vegetation a given territory opens its eyes to the Universe in spring and summer and shuts its eyes in autumn and winter, and as by opening and closing of our eyes we do in a way converse with the outer world, so too it is a kind of information or revelation from the Universe which the Earth receives by the opening and closing of its eyes through the life of plants.

And to describe it a little more precisely, we may consider the vegetation of a given region of the Earth when exposed, as it were, so to speak, to the most vivid interplay with the solar life, and we may then turn our attention to the state of vegetation in this region when it is not thus exposed. The winter, I need hardly say, does not interrupt the vegetative life of the Earth. It goes without saying that the vegetative life continues through the winter. But it expresses itself in quite another way than when exposed to the intensive working of the Sun's rays — or, shall we say, of the Cosmos. Under the influence of the solar life, the vegetative life of the Earth shoots outward into form. The leaves unfold and grow more complex; flowers develop. But when this is followed by the closing of the eyes to the Universe, if we may call it so, the vegetative life goes back into itself — into the seed. Withdrawing from the outer world, it no longer shoots into outward form; it concentrates, if I may put it so, into a point; it becomes centered in itself.

We may describe this contrast truly as a law of Nature. The interplay between the earthly and the solar life reveals itself in the Earth's vegetation. Under the solar influence the vegetative life shoots outward into form; under the influence of the earthly life it closes up into a plant, — it becomes seed or germ. In all this there is a quality of expansion and contraction or gathering into a center. Here we begin to apprehend the relationships of space itself in a directly qualitative aspect. This is the very thing which we must practice in the development of our ideas, if we would attain to really fruitful notions and perceptions in this sphere.

And now we pass from plant-life to the life of man. Naturally, what comes to expression in the life of plants will find expression in man too. In what way will it do so? What we somehow perceive, my dear Friends, so outwardly and evidently in the life of plants — what we have visibly before our eyes if only we are attentive to the qualitative aspect — this we can recognize in man, properly speaking, only in the first years of childhood.

Let us then trace the interaction of the solar and terrestrial life for man in the age of childhood, as we have just been doing for the plant kingdom. The little child opens through the senses to receive the impressions of the outer world. In doing so, the human being is really opening to receive the solar life. You only need see things in the proper light to recognize that what pours in upon our senses is inherently connected with what is brought about in the terrestrial sphere by the Cosmos. You can reflect upon the special case of light. When light and darkness succeed each other in the alternation of day and night, impressions are made upon our eyes by day, and no impressions are made by night. You can apply this also to other perceptions, though it is more difficult to make it clear. You will then say that a certain effect of the daily alternations, solar and earthly, expresses itself in man's soul-life. Man has an activity of soul through what arises in the rhythm of the day. What the Sun here brings to the Earth comes to expression in the soul-life of man. But if we follow the growth of the child, particularly until the 7th year — the change of teeth — and go into all the details, we find how,

notably in the first years of the child's development (less and less, the older the child becomes), it is plainly perceptible that the changing seasons, year by year, have just as much significance for human growth as for the sprouting and dying-down of the vegetation.

We will represent it diagrammatically. If, for example, we study carefully and intelligently the development of the human brain in the earliest stages from year to year, we shall find the following. We have the human skull with its brain-content. (Fig. 1)

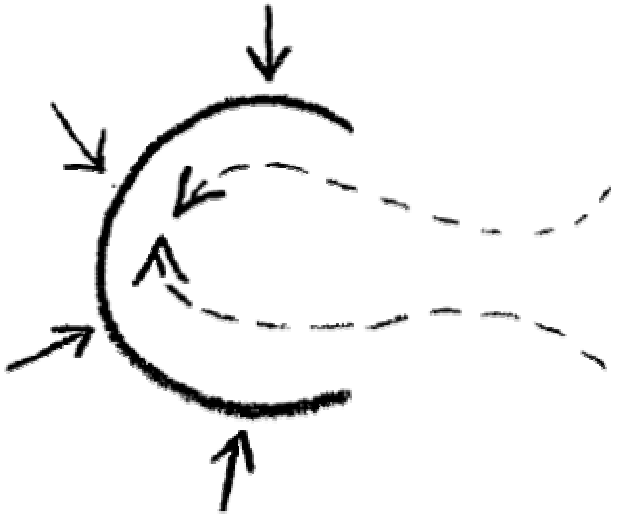

Fig. 1

It remodels itself, and one can follow how it remodels itself through what in the course of the changing year. Something which works formatively and creatively upon the human head, molding it from outside in a corporeal, physical sense, — we find this intimately connected with the forces playing between Earth and Sun in the course of the year. In the daily rhythm we find what enters through the senses, independent of growth, to work on the soul and spirit of man. We see how what takes place in man by reason of the Sun's activity in the daily rhythm, has an inner effect which frees itself from the external world and becomes of a soul-and-spirit nature it is what the child learns, what it assimilates through observation, what takes place in effect, in soul and spirit. Then we see how in a totally different tempo — from a different aspect — the brain remodels itself, organizes itself, and grows. That is the other activity, the yearly activity of the solar forces. We will say nothing yet of the changes occurring in the Universe between Sun and Earth; we will consider manifestations in man himself which are united with certain changes in the solar and terrestrial life.

We consider the day and find the soul- and spirit-life of man connected with the course of the Sun. We consider the change of seasons through the year and find man's life of growth, the physical, corporeal life, connected with the course of the Sun. We can say: The change taking place between Earth and Sun in 24 hours has certain effects on the spirit and soul of man. What happens between Earth and Sun in the course of the year has certain effects on the physical, corporeal part of man. We shall have to bring these effects into connection with others and thence arrive at a world-concept which can no longer be deceptive, for it speaks to us of real processes within ourselves, no longer dependent on illusory sense-impressions or the like.

Thus we must gradually draw near to what can give us a sure basis for the astronomical world-conception. We can only take our start from what appears in man himself. So we can say: the day is something in man's connection with the Cosmos that expresses itself in soul and spirit; the year is something in man's connection with the Cosmos that expresses itself in the physical-corporeal life, as for example in growth, and so on.

Now let us look at another complex of facts, referred to yesterday. With human reproduction we must relate certain ideas referring to the life of the Cosmos. We indicated yesterday that the female organism shows in a striking manner how the monthly functions connected with the sex-life — though not, to be sure, coinciding with the Moon's phases — are yet a reflection of them in their time rhythm. The process wrests itself free from the Cosmos, as it were, but still reflects the Cosmic Moon-process in its periodic course. We have here an indication, my dear friends, of inner processes in the human organism which we can study better if we turn our attention to more familiar phenomena, such as may make these more remote phenomena easier to understand.

There is something in the soul-life which actually reproduces in miniature the organic processes to which we have just alluded. Let us say, we have an outer experience which affects us through the senses and the mind, — perhaps also through our feelings. We retain a memory of the experience. The recollection — the retention of the experience — leads to the possibility of the picture of it emerging again at a later time. Anyone who considers these facts, not on the basis of fanciful theories, but with sound qualitative observation, will have to admit that in all that arises within us by way of memory, our physical bodily organization plays a part. The remembering itself is no doubt an event in the life of soul, but it needs the inner basis of the physical body in order to come into being. The activity of remembering is directly interrelated with bodily processes; though this has not yet been investigated sufficiently by external science. Comparing what occurs in the female organism in the monthly periods (it occurs in the male organism too, only it is less evident; it can be observed more in the etheric organism and this is not usually done) — comparing this with what happens in ordinary experience when we remember something, one will certainly find a difference. Yet if with sound inner perception one recreates the process in one's consciousness, one cannot but say that the activity of remembering, this soul-occurrence arising out of the physical organism, is similar to what takes place in the monthly functions of the female organism, only is in miniature and is more drawn into the realm of soul, less impressed upon the body. From this point of view you will be able to say: Inasmuch as man individualizes himself from the Cosmos, he develops the faculty of memory; inasmuch as he still lives within the Cosmos, developing more his sub-conscious functions, something in the nature of a common experience with the Cosmos arises, connected with the Moon-processes in the Cosmos. This experience remains, just as a past experience remains in our memory, and later it emerges in an inner constitutional process, like a remembrance which has been drawn into the body and has become organic.

There is no other way, my dear friends, of understanding these matters than by thus proceeding from the simpler to the more complex. Just as it is not necessary for a recollection to coincide with a fresh outer experience, so it is not necessary for what appears in the female organism, as a memory of an earlier cosmic connection of the human organism with the phases of the Moon, to coincide in time with these phases. Nevertheless, it is connected with the Moon's phases no less essentially than is the recollection of an earlier experience with the experience itself. Here then we have an activity in the human organism, more on the psychological side and yet not unlike the effects — precipitated, as it were, into the life of time — of influences due originally to the Moon. For the organic periodicity of which we have been speaking embraces about 28 days, as you know.

Now take the following. If we consider the daily influence of the Sun, we find an inner activity of soul and spirit; if we consider the yearly influence of the Sun, then we find laws of growth belonging to the outer physical body. Thus we can say, for the Sun life:

1. Soul and Spirit: Day

2. Physical bodily nature: Year

And now we come to the Lunar activity. We pass on to consider the lunar life, the life of the Moon. What I have just described as taking place in rhythm of 28 days belongs indeed to the soul and spirit; it has only impressed itself deeply into the body. Physiologically, there is really no difference, in a finer

sense, between what takes place in the body on the arising of a memory with respect tot the event to which the memory refers, and what takes place in the monthly periods of the female body with respect to what the female organism experienced long ago in conjunction with the phases of the Moon. Only the latter is a stronger, a more intensive experience, — a soul spiritual experience pressed more intensively into the body. Thus, for the Lunar life:

Soul and Spirit: 28 day's activity

Let us now seek the corresponding phenomena for the physical body. What will they be? You can find it for yourselves by deduction. We will have bodily, physical effects with a 28-year period. As a day here corresponds to a year, we shall have 28 years.

Physical bodily nature: 28 year's activity

You need only remember that 28 years is the period bringing us to our full inner maturity of growth. It is then that we first cease to be in the ascending scale of growth. Just as the Sun works upon us from outside in its yearly activity, in order to complete in us an outward process corresponding to the daily process in the inner life o soul and spirit, so something works in the Cosmos in a 28-year period, organizing us from outside even as the female human being is organized inwardly. (In her it is more obvious than in the male, for in the man the corresponding daily rhythm is more withdrawn into the etheric.) Here then a 28-day period impresses itself inwardly in the realm of the soul and spirit, and we can say: As the daily Sun-life is related to the yearly Sun-life in regard to man, so the 28-day Moon-life related to the 28-year Moon-life with respect to the whole man (the former belonging, in effect, more to the human head).

You see how we place man, and rightly place him, into the whole Cosmos. We leave off speaking of Sun and Moon merely as if we stood isolated here on Earth, and only looked out with our eyes or with our telescopes to Sun and Moon. We speak of Sun and Moon as of something inwardly united with our very life, and we perceive the connection in the special configurations of our life in time. Until we place man again, my dear friends, into the picture of the doings of Sun and Moon, we shall not have evolved a firm foundation for true Astronomy.

Thus a new science of Astronomy must be built upon a spiritual-scientific basis. It must be evolved out of a more intimate knowledge of man himself. We shall only be able to find a meaning in what is taught by the external Astronomy of today, when we are in a position to base our hypotheses on man himself. We shall then be able profitably to study the rather schematic statements made in Astronomy today and we shall also be able to make essential corrections in this external Astronomy.

What follows from all this? It follows that in these processes — no matter, for the moment, what the underlying basis of them is — a universal life reveals itself. Whether it by (and we will speak of this later) that the daily and yearly rotations of the Earth underlie what I have here described as solar life with respect to the soul and spirit for the day, and to the physical bodily nature for the year; whether it be the movements of the Moon described by modern Astronomy or something very different; — we shall never reach an understanding of it merely by setting up the well-known picture taught in the Schools. But we must understand all that is expressed in this picture as being in reality a continuing, enduring universal life — a life which cannot be approached in its fullness by a mere series of diagrammatic pictures.

We will now set to work in another way. We will Bet to work from the standpoint offered us in the Astronomical ideas of a man who still had very much from the past. We do not want to return to the older ideas; we must work out of new ideas This man, however, still had much of the old qualitative virtues in his ideas. I refer to Kepler. Astronomy has become more and more quantitative in modern time, and it would be a delusion to look on Astrophysics as the entry of a qualitative element into Astronomy; of an universal life that lay behind the work of Kepler. In him a feeling still persisted that

behind all that is manifest to ordinary astronomical observation there lies hidden something like the gesture of a vast cosmic life — a cosmic life that here reveals its presence.

If we have a man before us and see him move a hand or an arm, we do not merely calculate the mechanics of the movement; we recognize it as the outer revelation of an inner life of soul and spirit. We understand as an expressive gesture something that can, after all, also be looked on from a purely spatial, mathematical point of view. The further back one goes in the history of man's approach to Astronomy, the more one find men conscious that the pictures they conceived of the path of the Sun or of the stars were no mere passive pictures of indifferent events but that these pictures were gestures of life and being. It is quite easy to discern in olden times this feeling of the gesture-like nature of the movements of the heavenly bodies. When my hand moves through the air I shall not merely calculate its path, but in this path I see an expression of the soul . So did the earlier observer see in the path of the Moon an expression. of a life of soul. In all the movements of the heavenly bodies he saw expressions of a soul-nature lie pictures it somewhat in this s way — If I could held an umbrella here so that only my hand were seen, my hand would make an inexplicable movement, for I am there behind the umbrella; only the hand is to be seen. Somewhat in this way the men of ancient times pictured that the movement of the Moon up in the sky was but the outer expression — a sort of terminal 'limb' — end that the really active being stood behind it. So too in earlier times men did not speak of isolated heavenly bodies of the planets; they spoke of planetary spheres. They spoke of the several spheres, belonging to the heavenly bodies. Thus they distinguished the Moon-sphere, the Mercury-sphere, the Venus-sphere, the Sun-sphere, the Mars-sphere, the Jupiter-sphere, the Saturn-sphere, and then the eighth sphere — the Heaven of Fixed Stars They distinguished these eight spheres and saw in them something which expressed itself in outer gestures, so that a certain sphere expressed itself by lighting up now here, now there, and so on. The reality, for instance, was the sphere of the Moon. The Moon itself was not a separate entity, — only the gesture. Where the Moon appeared, the Moon-sphere was making a definite gesture I am relating this to show you the living nature of the old conceptions.

Kepler still retained in his whole consciousness a feeling for this universal life in space Only on this account was he able to draw up his three famous Laws For modern Astronomy the three famous Laws of Kepler are purely of a quantitative nature, to be regarded simply from the aspect of spatial and temporal concepts. For a man who still worked out of such a life of ideas as Kepler did, this was not the case. Let us now call to mind these Laws of Kepler. They are:

The First Law:
The Planets move in ellipses round the central body, which is situated in one of the foci of the ellipse.

The Second Law:
The Radius-vector of a Planet describes equal sectors, equal areas, in equal periods of time.

The Third Law:
The squares of the periods of revolution of the different Planets are proportional to the cubes of the major semi-axes

Now as we said, to the modern, purely quantitative view these laws too are purely quantitative To anyone like Kepler, the very expression 'elliptical' and the corresponding curve signified a greater livingness when it only moves in a circle, for it must use an inner impulse in order continually to alter the radius. When something simply moves in a circle it need do nothing to alter the radius. A more intense inner life must be employed in the radius-vector is continually altered. The simple. statement: "The Planets move in ellipses round the central body and the central body is not in the mid-point but in one of the foci of the ellipse", implied an element of greater livingness than when something moves in a perfect circle.

Further: “The radius-vector describes equal sectors in equal periods of time”. We have here the transition from the line to the surface, to the plane. Please notice this.’ Inasmuch as at first only the ellipse is described, we remain in the line — the curve. When we are directed to the path that the radius-vector describes, we are led to the surface — the area. A more intensive condition in the planetary movement is disclosed, When the planet ‘rolls along’ — if I may express so myself — it is not only expressing something within itself, but draws its tail after it, as it were. The whole area which the radius-vector describes belongs to it spiritually. Moreover, in equal periods of time equal areas are described, Special attention is thus drawn to the quality, the inherent character of the movement of the planets.

The third Law above all relates to the life that plays its part between the various planets. This Law assumes a more complicated form. “The squares of the periods of revolution of the Planets are in proportion to the cubes of the semi-major axes” (or of the mean distance from the central body). This Law, you see, contains a great deal if one still understands it in Kepler's living way. Newton then killed the law. He did this in a very simple fashion. Take Kepler's Third Law. You can write it thus:

$$t_1^2 : t_2^2 = r_1^3 : r_2^3$$

or written differently:

$$\frac{t_1^2}{r_1} : \frac{t_2^2}{r_2} = r_1^2 : r_2^2 .$$

Now write it in a somewhat different form. Write it thus:

$$\frac{1}{r_1^2} : \frac{1}{r_2^2} = \frac{r_1}{t_1^2} : \frac{r_2}{t_2^2}.$$

(I might of course also have written it in the reverse order.)

What have we on the left-hand side of the equation, here in the left-hand ratio? No less than what is expressed by one half of Newton's Law, and on the other side the other half, the forces of Newton's Law. You need only write Kepler's Law thus differently and you can say: “The forces or attraction are inversely proportional to the squares of the distances.” Here then you have the Newtonian Law of Gravity deduced from the Law of Kepler. The force of gravity between the planets, the celestial bodies, is in inverse proportion to the squares of their distances apart. It is nothing else than the killing of Kepler's Third Law. In principle that is what it is.

But now take the matter actively and livingly. Do not set before yourself the dead product “force of gravity” — “the forces of attraction decrease with the squares of the distances”, — but take what is living still in Kepler's form, the squares of the periods of time. Fill out the caput mortum of the Newtonian force of attraction, which is a mere external concept, with what is implied in the square of the period of time, and you will fill with inner life of the Newtonian concept, which is really the corpse of an idea! For inner life has to do with time. And here you have before you not only time in its simple course, you have time squared — time to the second power! We shall yet have to come back to what it means to speak of ‘time squared’ But you can realize that to speak of time to the second power is to speak or something of an inward nature. It is, indeed, time which in the life of man actually

represents the course of his inner soul-life. The point is that we should look right through it dead concept of the Newtonian force of attraction to that which suddenly darts into the center, bringing time into it and therewith bringing in an element of inner life.

Now look at the matter from another point of view. Notice that Kepler's first Law also has reference to the Earth. Not only does the Earth describe an ellipse, but you, since you are on the Earth, describe an ellipse together with it. What takes place outwardly is in you an inner process. Thus the arising of the ellipse from the circle, in the living way in which Kepler still conceived it, corresponds to a process in your own inner being. And inasmuch as you move in the line which is formed by the radius-vector describing equal sectors in equal times, it is you who continually relate yourself to the central body, placing yourself in relation to your own Sun. You, together with the curve, are describing a path in time, along which you are in continual relation to the Sun. If I may put it a little quaintly You must take care all the time that you do not 'skid' or side-slip, that you do not go too fast, — that your radius-vector does not describe too great an area. This outer point which moves in the ellipse must be continuously in the right relation to the Sun. There you have the movement you yourselves make, characterized as a pure line in space. The relation to the Sun is characterized in the Second Law.

And if we pass on to the Third Law, you have an inner experience of the relation to the other planets — your own living connection with the other planets.

Thus we not only have to find, in man himself, processes that lead us out again into the Cosmos. If we interpret rightly the mathematical pictures presented to us by the cosmic process, we also turn into an inner experience what is apparently external and quantitative. For the cosmic Mathematics indwells man. Man is himself in the midst of the living Mathematics. Of this we shall speak more tomorrow.

Lecture IV
Stuttgart, January 4, 1921

My Dear Friends,

If I had the task of presenting my subject purely according to the methods of Spiritual Science, I should naturally have to start from different premises and we should be able to reach our goal more quickly. Such a presentation, however, would not fulfill the special purpose of these lectures. For the whole point of these lectures is to throw a bridge across to the customary methods of scientific thought. Admittedly, I have chosen just the material which makes the bridge most difficult to construct, because the customary mode of thought in this realm is very far from realistic. But in contending against an unreal point of view, it will become apparent how we can emerge from the unsatisfying nature of modern theories and came to a true grasp of the facts in question. Today, then, I should like to consider the whole way in which ideas have been formed in modern times about the celestial phenomena.

We must, however, distinguish two things in the formation of these ideas. First, the ideas[1] are derived from observation of the celestial phenomena, and theoretical explanations are then linked on to the observations. Sometimes very far-reaching, spun-out theories have been linked on to relatively few observations. That is the one thing, namely, that a start is made from observations out of which certain ideas have been developed. The other is that, there ideas having been reached, they are further elaborated into hypotheses. In this creating of hypotheses, — a process which ends in the setting up of some definite cosmology, — much arbitrariness prevails, since in the setting-up of theories, any preconceived ideas existing in the minds of those who put forward the theory, make themselves strongly felt.

I will therefore first call your attention to something which will perhaps strike you as paradoxical, but which, when carefully examined, will none the less prove fruitful in the further course of our studies.

In the whole mode of thought of modern Science there prevails what might be called, and indeed has been called, the ‘Regula philosophandi’. It consists in saying: What has been traced to definite causes in one realm of reality, is to be traced to the same causes in other realms. In setting up such a ‘regula philosophandi’ the starting-point is as a rule apparently self-evident. It will be said — scientists of the Newtonian school will certainly say — that breathing must have the same causes in man in the animal, or again, that the ignition of a piece of wood must have the same cause whether in Europe or in America. Up to this point the thing is obvious enough. But then a jump is made which passes unnoticed, — is taken tacitly for granted. Those who are wont to think in this way will say, for example, that if a candle and the Sun are both of them shedding light the same causes must surely underlie the light of the candle and the light of the Sun. Or again, if a stone falls to Earth and the Moon circles round the Earth, the same causes must underlie the movement of the stone and the movement of the Moon. to such an explanation they attach the further thought that if this were not so, we should have no explanations at all in Astronomy. The explanations are based on earthly things. If the same causality did not obtain in the Heavens as on Earth, we should not be able to arrive at any theory at all.

Yet when you come to think of it, this ‘regula philosophandi’ is none other than a preconceived idea. Who in the world will guarantee that the causes of the shining of a candle and of the shining of the Sun are one and the same? Or that in the falling of a stone, or the falling of the famous apple from the tree by which Newton arrived at his theory, there is the same underlying cause as in the movements of the heavenly bodies? This would first have to be established. As it is, it is a mere preconceived idea. Prejudices of this kind enter in, when, having first derived theoretical explanations

and thought — pictures inductively from the observed phenomena, people rush headlong into deductive reasoning and construct world-systems by deductive methods.

What I am now describing thus abstractly has, however, become a historical fact. There is a continuous line of development from what the great thinkers at the opening of the modern age — Copernicus, Kepler, Galileo — concluded from comparatively few observations. Of Kepler — notably of his third Law, quoted yesterday — it must be said that his analysis of the facts which were available to him is a work of genius.

It was a very great intensity of spiritual force which Kepler brought to bear when, from the little that lay before him, he discovered this 'law' as we call it, or better, this 'conceptual synthesis' of the phenomena of the universe. Then however, by way of Newton a development set in which was not derived from observation but from theoretical constructions, including concepts of force and mass and the like, which we must simply omit if we only want to hold to what is given. The development in this direction reaches a culminating point — conceived, admittedly, with genius and originality — in Laplace, where it leads to a genetic explanation of the entire cosmic system (as you will convince yourselves if you read his famous book "Exposition du Systeme du Monde"), or again in Kant, in his "Natural History and Theory of the Heavens". In all that has followed in this trend we see the effort constantly made to come to conclusions based on the thought pictures that have thus been conceived of the connections of the celestial movements, and resulting in such explanations of the origin of the universe as the nebular theory and so on.

It must be noted that in the historical development of these theories we have something which is put together from inductions made, once again, with no little genius in this domain — and from subsequent deductions in which the special predilections of their authors were included. Inasmuch as a thinker was imbued with materialism it was quite natural for him to mingle materialistic ideas with his deductive concepts. Then it was no longer the facts which spoke, for one proceeded on the basis of the theories which had emerged from the deductions. Thus, for example, inductively men first arrived at the mental pictures which they summed up in the notion of a central body, the Sun, with the planets revolving around it in ellipses according to a certain law, namely: the radius-vectors describe equal areas in equal periods of time. By observing the different planets of a solar system, it was moreover possible to summarize their mutual relations in Kepler's third law: 'For different planets the squares of the periods of revolution are proportional to the cubes of the radius-vectors'. Here was a certain picture. The question, however, was not decided, whether this picture completely fitted the reality. It was in truth an abstraction from reality; to what extent it related to the full reality, was not established. From this picture — not from reality, but from this picture — people deduced what then became a whole genetic system of Astronomy. All this must be borne in mind. Modern man is taught from childhood as if the theories which have been reached in the past few centuries by deductive reasoning were the real facts. We will threrfore, while taking our start from what is truly scientific, disregard as far as is possible all that is merely theoretical and link on to those ideas which only depart from reality to the extent that we shall still be able to discover in them a connection with what is real. It will be my task, in all that I give to-day, to follow the direction of modern scientific thought only up to those ideas and concepts which still permit one to find the way back again into reality. I shall not depart so far from reality that the concepts become crude enough to allow of the deduction of nebular hypotheses.

Proceeding in this way, — pursuing the modern method of forming concepts in this particular field, — we must first form a concept which presented itself inductively to Kepler and was then developed further I repeat expressly, I will only go so far in these concepts that even if the picture in the form in which it was conceived should be mistaken, it has departed only so far from reality that it will be possible to eliminate the mistake and return to what is true. We need to develop a certain flair for reality in the concepts we entertain. We cannot proceed in any other way if we wish to throw a bridge across from the reality to the spun-out theories of modern scholarship and science.

Here then, to begin with, is a concept which we must examine. The planets have eccentric orbits, — they describe ellipses. This is something with which we can begin. The planets have eccentric orbits and describe ellipses, in one focus of which is the Sun. They describe the ellipses in accordance with the law that the radius — vectors describe equal areas in equal periods of time.

A second essential for us to hold to is the idea that each planet has its own orbital plane. Although the planets carry out their evolutions in the neighborhood of each other, so to speak, yet for each planet there is the distinct plane of its orbit, more or less inclined to the plane of the Sun's equator: If this depicts the plane of the Sun's equator (Fig.1), an orbital plane of a planet would be thus; it would not coincide at all with the plane of the Sun's equator. [2]

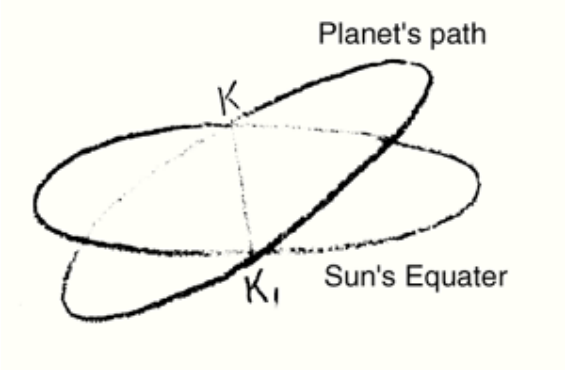

Fig. 1

These are two very significant mental pictures, to be formed from the facts of observation. And yet, in the very forming of them we must take note of something in the real world-picture, which as it were, rebels against them. For instance, if we are trying to understand our solar system in its totality, and only base it upon the picture of the planets moving in eccentric orbits, the orbital planes being inclined at varying degrees to the plane of the solar equator, we shall be in difficulties if we also take into account the movements of the comets. The moment we turn our attention to the cometary movements, the picture no longer suffices. The outcome will be better understood from the historical facts than from any theoretical explanations.

Upon these two thought-pictures, — that the orbital planes of the planets lie in the proximity of the plane of the Sun's equator, and that the orbits are eccentric ellipses, — Kant, Laplace and their successors built up the nebular hypothesis. Follow what emerges from this. At a pinch, and indeed only at a pinch, it is a way of imagining the origin of the solar system. But the astronomical system thus constructed contains no satisfactory explanation of the part played by the cometary bodies. They always fall out of the theory. This discordance of the comets with the theories which were formed, as described, in the course of scientific history, proves that the cometary life somehow rebels against a concept formed, not from the whole but only from a part of the whole. We must be clear, too, that the paths of the comets frequently coincide with those of other bodies which also play into our system and present a riddle precisely through their association with the comets. These are the meteoric swarms, whose paths very frequently — perhaps even always — coincide with the cometary paths. Here, my dear friends, taking into account the totality of our system, we are led to say: A sea of ideas has gradually been formed from the study of our planetary system as a whole, — ideas with which we cannot do justice to the seemingly irregular and almost arbitrary paths of the comets and meteoric swarms. They simply refuse to be included in the more abstract pictures that have been reached. I should have to give you long historical descriptions to show in detail how many difficulties have arisen in connection with the concrete facts, when the investigators — or rather, thinkers — approached the comets and meteoric swarms with their astronomical theories.

I wish only to point out the directions in which a sound understanding can be sought. We shall come to such an understanding if we pay attention to yet another aspect.

Starting in this way from concepts which still have a remnant of reality in them, we will now try to go back a little towards what is real. It is indeed always necessary to do this in relation to the outer world, in order that our concepts may not stray too far from reality, — for this is a strong propensity of man. We must go back again and again to the reality.

There is already no little danger in forming such a concept as that the planets move in ellipses, and then beginning at once to build a theory upon this concept. It is far better, after forming such a concept, to turn back to reality in order to see if the concept does not need correcting, or at least modifying. This is important. It is very clearly seen in astronomical thinking. Also in biological and especially in medical thought, the same failing has led people very far astray. They do not take into account, how necessary it is directly they have formed a concept, to go back to reality in order to make sure that there is no reason to modify it.

The planets, then, move in ellipses. But these ellipses vary; they are sometimes more circular, sometimes more elliptical. We find this if we return to reality with the ellipse idea. In the course of time the ellipse becomes more bulging, more like a circle, and then again more like an ellipse. So I by no means include the whole reality if I merely say, ‘the planets move in ellipses’. I must modify the concept and say: The planets move in paths which continually struggle against becoming a circle or remaining one and the same ellipse. If I were now to draw the elliptic line, to be true to the reality I should have to make it of india-rubber, or form it flexibly in some way, continually altering it within itself. For if I had formed the ellipse which is there is one revolution of the planet, it would not do for the next revolution, and still less for the following one. It is not true that when I pass from reality to the rigid concept I still remain within the real. That is the one thing.

The other is: We have said that the planes of the planetary orbits are inclined to the plane of the Sun's equator. Where the planets cross the point of intersection of their orbits (with the Ecliptic) in an upward or downward direction, they are said to form Nodes. The lines, joining the two Nodes (K-K 1 in Fig. 1), are variable. So too are the inclinations of the planes to one-another, so that even these inclinations, if we try to express them in a single concept, bring us to a rigid concept which we must immediately modify in face of the reality. For if an orbit is inclined at one time in one way, and at another time in another way, the concept we deduce in the first instance must afterwards be modified. To be sure, once such a point has been reached, we can take an easy line and say that there are ‘disturbances’ and that the reality is only grasped ‘approximately’ with our concepts. We then go on swimming comfortably in further theories. But in the end we swim so far that the fanciful and theoretic pictures we are constructing no longer correspond to the reality, though they are meant to do so.

It is easy to agree that this mutability of the eccentric orbits, and of the mutual inclination of the planes of the orbits, must somehow or other be connected with the life of the whole planetary system, or shall we say, with its continuing activity. It must be connected in some way with the living activity of the whole planetary system. That is quite evident. Starting from this, one might again try to form the concept, saying: Well now, I will bring such mobility into my thoughts that I picture the ellipses continually bulging out and contracting, the planes of the orbits ascending, descending and rotating, and then from this starting-point I will build up a world-system according to reality. Good. But if you think the idea through to the end, then precisely as the outcome of such logical thought, the result is a planetary system which cannot possibly go on existing. Through the summation of the disturbances which arise especially through the variability of the Nodes, the planetary system would move towards its own ultimate death and rigidity. Here there comes in what philosophers have pointed out again and again. While such a system can be thought out, in reality it would have had ample time to reach the ultimate finale. There is no reason why it should not, The infinite possibility would have been fulfilled; ridigity would long ago have set in.

We enter here into a realm where thought apparently comes to a standstill. Precisely by following my thinking through to the very last, I arrive at a world-system which is still and rigid. But that is not reality.

Now, however, we come to something else, to which we must pay special attention. In pursuing these things further — you can find the theory of it in the work of Laplace; I will only relate the phenomena — one finds that the reason why the system has not actually reached rigidity under the influence of the disturbances — the variability of the Nodes, etc., — is that the ratios of the periods of revolution of the planets are not commensurable. They are incommensurable quantities, numbers with decimals to an infinite number of places. Thus we must say: If we compare the periods of revolution of the planets in the sense of Kepler's Third Law, the ratios of these periods cannot be given in integers, nor in finite fractions, but only in incommensurable numbers. Modern Astronomy is clear on this. It is to the incommensurability of the ratios between the periods of revolution of the several planets (in Kepler's third Law) that the planetary system owes its continued mobility. Otherwise, it must long ago have come to a standstill.

Observe now, what has happened. In the last resort, we are obliged to base our thoughts about the planetary system upon numbers which in the end elude our grasp. This is of no little importance.

We are therefore led, by the very requirements of scientific development, to think of the planetary system mathematically in such a way that the mathematical results are no longer commensurable. We are at the place, where in the mathematical process itself we arrive at incommensurable numbers. We have to let the number stand, — we come to a stop. We can write it in decimals no doubt, but only up to a certain place. Somewhere or other we must leave off when we come to the incommensurable. The mathematicians among you will be clear about this. You will see that in dealing with incommensurable number I reach the point where I must say: I calculate up to here and then I can go no further. I can only say (forgive my using a somewhat amusing comparison for a serious subject) that this coming to an inevitable halt in mathematics reminds me of a scene in which I was once a participator in Berlin. A fashion in Variety-entertainment came about through certain persons, one of whom was Peter Hill. He had founded a kind of Cabaret and wanted to read his own poems there. He was a very lovable person, in heart and soul a Theosophist, he had rather gone to seed in Bohemian circles. I went to a performance in which he read his own poems. The poem had got so far that single lines were finished, and so he read it aloud:

The Sun came up. ... etc. (The first line.)

The Moon rose. ... etc. (That was the second line.)

At each line he said ‘etc.’ That was a reading I once attended. As a matter of fact it was most stimulating. Everyone could finish the line as he chose! Admittedly with incommensurable numbers cannot do this, yet here too you can only indicate the further process. You can say that the process continues in a certain direction, but nothing is given by which you might form an idea as to what numbers may yet be coming. It is important that precisely in the astronomical field we are led into incommensurabilities. We are forced by Astronomy to the very limits of mathematising; here the reality escapes us. Reality escapes us, we can say nothing else; reality eludes our grasp.

What does this mean? It means that we apply the most secure of our sciences, Mathematics, to the celestial phenomena, and in the last resort the celestial phenomena do not submit; the moment comes where they elude us. Precisely where we are about to reach their very life, they slip away into the incommensurable realm. Here then, our grasp of reality comes to an end at a certain point and passes over into chaos.

We cannot say without more ado, what this reality, which we are trying to follow mathematically, actually does when it slides away into the incommensurable. Undoubtedly this is related to its power

of continued life. To enter the full astronomical reality we must take leave of what we are able to master mathematically. The calculation plainly shows this; the very history of science shows it.

Such are the points which we must work towards, if we would proceed in a realistic spirit. Now I would like to set before you the other pole of the matter. If you follow it physiologically you can begin from any point you line in embryonic development, whether it be from the development of the human embryo in the third or second month, — or the embryo of some other creature. You can follow the development back as far as ever you can with the means of modern science. (it is in fact only possible to a limited extent, as those of you who have studied it will know.) You can trace it back to a certain point, from which you cannot get much further, namely to the detachment of the ovum — the fertilized ovum. Picture to yourselves how far you can go back. If you wished to go still further back you would be entering the indeterminate realm of the whole maternal organism. This means that in going back you come into a kind of chaos. You cannot avoid this, and the fact that it cannot be avoided is shown by the course of scientific development. Think of such scientific hypotheses as the theory of "Panspermia" for instance, where they speculated as to whether the single germ-cell was prepared out of the forces of the whole organism, which was more the point of view of Darwin, or whether it developed in a more segregated way in the purely sexual organs. You will see when you study the course of scientific development in this field that no little fantasy was brought to bear on the attempt to explain the underlying genesis, when tracing backward the arising of the germ cell from the maternal organism. You come into completely indeterminate realm. There is little but speculation in the external science of today as to the connection between the germ-cell and the maternal organism.

Then at a certain point in its development this germ appears in a very definite way, in a form which can be grasped at least approximately by mathematical or at any rate geometrical means. Diagrams can be made from a certain point onward. Many such diagrams exist in Embryology. The development of the germ-cell and other cells can be delineated more or less exactly. So one begins to picture the development in a geometrical way, representing it in forms similar to purely geometrical figures. Here we are following up a reality which in a way is the reverse of what we had in Astronomy. There we pursued a reality with our cognitional process and came to incommensurable numbers; the whole thing slips into chaos through the process of knowledge itself. In Embryology we slip out of chaos. From a certain moment onward we can grasp what emerges from chaos through forms that are like purely geometrical forms. Thus in effect, in employing Mathematics in Astronomy we come at one point into chaos. And by pure observation in Embryology we have at a certain point nothing before us but chaos; it all seems chaotic at first, observation is impossible. Then we come out of chaos into the realm of Geometry. It is therefore an ideal of certain biologists — a very justifiable ideal — to grasp in a geometrical form what presents itself in Embryology; not merely to make illustrations of the growing embryo naturalistically, but to construct the forms according to some inherent law, similar to the laws underlying geometrical figures. It is a justifiable ideal.

Now therefore we can say: When in Embryology we try to follow up the real process by observation, we emerge out of a sphere which lies about as near to our understanding as that which is beyond the incommensurable numbers. In Astronomy on the one hand, we proceed with our understanding up to the point where we can no longer follow mathematically. In Embryology on the other hand our understanding begins at a certain point, where we are first able to set to work with something resembling Geometry.

Think the thought through to its conclusion. You can do so, since it is a purely 'methodological' thought, that is to say the reality of it is in our own inner life.

If in arithmetic we reach the incommensurable numbers, — that is, we reach a point where the reality is no longer represented by a number that can be shown in its complete form — then we should also begin to ask whether the same thing may not happen with geometrical form as with arithmetical analysis. (We shall speak more of this in the next lecture.) The analytical process leads to incommensurable number. Now let us ask: How do geometrical forms image the celestial movements? Do not these images perhaps lead us to a certain point. Similar to that to which arithmetical analysis is

leading when we reach incommensurable number? Do we not in our study of the heavenly bodies — namely the planets — come to a boundary, at which we must admit we can no longer use geometrical forms as a means of illustration; the facts can no longer be grasped with geometrical forms? Just as we must leave the region of commensurable numbers, it may well be that we must leave the region where reality can still be clothed in geometrical (or again arithmetical, algebraic, analytical) forms, such as in drawings of spirals and other figures derived from Geometry. So, in Geometry too, we should be coming into the incommensurable realm. In this sense it is indeed remarkable that in Embryology, though arithmetical analysis is not yet of much use, Geometry makes its presence felt pretty strongly the moment we begin to take hold of the embryological phenomena as they emerge from chaos. Here we are dealing, not indeed with incommensurable number but with something that tends to pass from incommensurable into commensurable form.

We have thus sought to grasp reality at two poles: On the one hand where the process of cognition leads through analysis into the incommensurable, and on the other where observation leads out of chaos to a grasping of reality in ever more commensurable forms. It is essential that we bring these things before our minds with full clarity, if we would add reality to what is presented by the external science of today. In no other way can we reach this end.

I should now like to add a methodical reflection, from which we can tomorrow make our way into more realistic problems.

In all that we have spoken of hitherto, we have been taking it for granted that the cosmic phenomena have been approached from the standpoint of Mathematics. It appeared that at one point the mathematician comes up to a limit — a limit he encounters too in purely formal Mathematics. Now there is something underlying our whole way of thinking in this realm, which perhaps passes unnoticed because it always wears the mask of the ‘obvious’ and we therefore never really face the problem. I mean the whole question of the application of mathematics to reality. How do we proceed? We develop Mathematics as a formal science and it appears to us absolutely cogent in its conclusions; then we apply it to reality, without giving a thought to the fact that we are really doing so on the basis of certain hypotheses. Today however, sufficient ground has already been created for us to see that Mathematics is only applicable to outer reality on the basis of certain premises. This becomes clear when we try to continue Mathematics beyond certain limits. First, certain laws are developed, — laws which are not obtained from external facts, as for example are Kepler's Laws, but from the mathematical process itself. They are in fact inductive laws, developed within Mathematics. They are then employed deductively; highly elaborate mathematical theories are built upon them.

Such laws are those encountered by anyone who studies Mathematics. In lectures given recently in Dornach by our friend Dr. Blumel, significant indications were given of this line of mathematical research. One of the laws in question is termed the Commutative Law. It can be expressed in saying: It is obvious that a + b equals b + a , or a x b equals b x a . This is a self-evident fact so long as one remains within the realm of real numbers: But it is merely an inductive law derived from the use of the implicit postulates in the arithmetic of real numbers.

The second law is the Associative Law. It is expressed as (a + b) + c = a + (b + c). Again this is a law, simply derived by working with the implicit postulates in the arithmetic of real numbers.

The third is the so-called Distributive Law, expressible in the form: a (b + c) = ab + ac. Once more, it is a law obtained inductively by working with the implicit postulates in the arithmetic of real numbers.

The fourth law may be expressed as follows: ‘A product can only equal zero if at least one of the factors equals zero.’ This law again is only an inductive one, derived by working with the implicit postulates in the arithmetic of real numbers.

We have, then, these four laws; the commutative law, the associative law, the distributive law, and this law about the product being equal to zero. These laws underlie the formal Mathematics of today, and are used as a basis for further work. The results are most interesting, there is no question of that. But the point is this: These laws hold good so long as we remain in the sphere of real numbers and their postulates. But no thought is ever given to the question, to what extent the real facts are in accord with them. Within our ordinary formal modes of experience it is true, no doubt that a + b = b + a, but does it also hold good in outer reality? There is no ascertainable reason why it should. We might be very astonished one day to find that it did not work if we applied to some real process the idea that a + b equals b + a. But there is another side to it. We have within us a very strong inclination to cling to these laws; with them therefore. We approach reality and everything that does not fit in escapes our observation. That is the other side.

In other words: We first set up postulates which we then apply to reality and take them as axioms of the reality itself. We ought only to say: I will consider a certain sphere of reality and see how far I get with the statement a + b = b + a. More than that, I have no right to say. For by approaching reality with this statement we meet what answers to it, and elbow aside anything that does not. We have this habit too in other fields. We say for example, in elementary physics: Bodies are subject to the law of inertia. We define 'inertia' as consisting in the fact that bodies do not leave their position or alter their state of motion without a definite impelling force. But that is not an axiom; it is a postulate. I ought only so say: I will call a body which does not alter its own state of motion 'inert', and now I will seek in the real world for whatever answers to this postulate.

In that I form certain concepts, I am therefore only forming guiding lines with which to penetrate reality, and I must keep the way open in my mind for penetrating other facts with other concepts. Therefore I only regard the four basic laws of number in the right way if I see them as something which gives me a certain direction, something which helps me regulate my approach to reality. I shall wrong if I take Mathematics as constituting reality, for then in certain fields, reality will simply contradict me. Such a contradiction is the one I spoke of, where incommensurability enters in, in the study of celestial phenomena.

Notes:

1. Note by translators: In the first few pages of this lecture, the word Vorstellungen has been translated, either as "mental pictures" or "thought-pictures", or by the word "ideas" as in Prof. Hoernle's original English edition of Dr. Steiner's Philosophie der Freiheit. In other translations, including the later editions of this book, the word is rendered "representations", or again, "Mental presentations". Dr. Steiner's use of Vorstellung corresponds, we believe, to the colloquial, work-a-day meaning of the word "idea" in current English. (Where Idea is meant in its deeper, more spiritual meaning — German Idee — it can be distinguished by the use of a capital.)

2. Note by Editor: This plane is inclined at an angle of about seven degrees to the plane of the ecliptic.

Lecture V
Stuttgart, January 5, 1921

My Dear Friends,

For the further progress of our studies I must today insert a kind of interlude, for we shall then understand more easily the real nature of our task. From a particular point of view we will reflect on the cognitional theory of Natural Science altogether. Let us link on to yesterday's lecture by calling to mind once more the provisional conclusions to which we came. The verification of them will emerge in the further course.

We have seen that in the study of celestial phenomena, in so far as these are expressed by our Astronomy in geometrical forms and arithmetical figures, we are led to incommensurable qualities. There is a moment in our process of cognition — in the attempt to understand the celestial phenomena — when we must come to a standstill, as it were, and can no longer declare the mathematical method to be competent. From a certain point onward, we simply cannot continue merely to draw geometrical lines, tracing the movements of the heavenly bodies. We can no longer employ mathematical analysis; we can only admit that analysis and geometry take us up to a certain point, whence we can go no further. At least provisionally, we come to the very significant conclusion that in reflecting on what we see, whether with the naked eye or with the aid of instruments, we can never fully compass it was geometrical figures or mathematical formulae. We do not contain the whole of the phenomena in algebra, analysis and geometry.

Think of the significance of this. If we are claiming to include the totality of the celestial phenomena, We must no longer imagine that we can do so by thinking of the Sun as moving in such a way that its movement can be represented by a definite geometry line, or that the Moon's movement can be so represented. Precise our most ardent wish must be renounced when we confront the phenomena in their totality. This is the more significant, since nowadays, the moment someone says ‘The Copernican System works no more satisfactorily than the Ptolemaic’, someone else will answer, ‘Let us then design another system’. We shall see the in the further course of these lectures, what must be put in the place of mere geometrical designs in order to comprehend the phenomena in their totality.

I must put this negative aspect before you first, before we can enter into the positive, for it is most important that we clear our thought in this respect.

On the other hand, we saw yesterday that what confronts us in Embryology emerges as if from indefinite, chaotic regions, and from a certain point onward can be grasped in picture-form, or even geometrically. As I said yesterday, in studying the celestial phenomena, through the very process of cognition we come to a point where we must recognize that the world is different from what this process of cognition might at first have led us to believe. And in the embryonic phenomena we are led to see that there must be something which preceeds the facts to which we still have access.

Now among other things there recently appeared a certain divergence of outlook among embryologists. (I will only give a rough description.) On the one hand there were the strict followers of biogenetic law, which states, as you know, that the development of the individual embryo is a kind of shortened recapitulation of the development of the race. These people wished to trace the cause of the development of the embryo to the development of the race. On the other hand, others came forward who would not hear of the derivation of the individual from the racial development, but held to a more or less mechanical conception of embryonic development saying that it was only necessary to take into account the forces directly present in what takes place in the embryo itself. For example, Oscar Hertwig left the strict biogenetic school of Haeckel and changed over to the more mechanical school. Now the mechanical needs to be grasped in a way that is at least similar to mathematics even though it be not pure mathematics. We therefore see, from the very history of Science, how front a

certain stage onward (something as I said, must be presumed to have gone before this stage) embryological development is taken hold of by a mechanical, mathematical method of research. It is the history of these things to which I now wish to point.

All this appears in the field which one might call the theory of knowledge. On the one hand we are driven to a boundary in the cognitional process, where we can get no further with our favorite modern method of approach. On the other hand, in studying the embryonic life our only possibility of grasping it with ordinary methods is to start from a certain point: what goes before this has to be taken fro granted. We must admit that we find something in the realm of reality, the beginnings of which we must leave vague and unexplored; then from a certain point onward we can set to work, describing what we observe in terms of diagrams, formulas and relationships which are at least similar to those of mathematics and mechanics.

Bearing these things in mind, I deem it necessary in today's lecture to insert a kind of general reflection. As I have often pointed out, it is the ideal of modern scientific research to observe outer Nature as independently of man as possible, — to establish the phenomena in pure objectivity, as it were, excluding man altogether from the picture. We shall see that precisely through this method of excluding, it is impossible to transcend such barriers as we have now observed from two distinct sides.

This is connected with the fact that the principle of metamorphosis, which, as you know,was first conceived and presented in an elementary way by Goethe, ha so far hardly been followed up at all. It has no doubt been used to some extent in morphology, yet even here, as we saw yesterday, one essential principle is lacking. Morphology today cannot yet recognize the form and construction of a tubular or long bone, for example, in its relation to that of a skull-bone. To do this, we should have to reach a way of thinking whereby we should first study what is within, say, the inner surface of a tubular bone and then relate this to the outer surface of a skull-bone. This means a kind of inversion, as when a glove is turned inside-out; but at the same time there is an alteration of the form, an alteration of the surface-tensions through the reversing or turning of inside outward. Only if we follow the metamorphosis of forms in this way, though it may seem complicated, shall we reach true conclusions.

But when we leave the morphological and enter more into the functional domain, there are but the barest indications, in the existing ways of thought, towards a true pursuit of the idea of metamorphosis in this domain. Yet this is what is needed. A beginning was made in my book, “Riddles of the Soul”, wherein I indicated at least sketchily — the three-foldness of the being of man, recognized as a sum-total of interrelated functions. At least in outline, I explained how we must first distinguish those functions and processes in man which may be regarded as belonging to the nerves and senses; how we then have to recognize, as relatively independent processes, all that is rhythmical in the human organism; and how again we must recognize the metabolic processes as distinct. I pointed out that in these three forms of processes all that is functional in man is included. Anything else which appears functional in the human organism is derivable from these three.

It is essential to see that all phenomena in the organic realm although appearing outwardly side by side, are related to one-another through the principle of metamorphosis. People today are disinclined to look at things macroscopically. We must find our way back to the macroscopic aspect. Otherwise, through the very lack of synthetic understanding of what is living, problems will arise which are not inherently insoluble, but are made so by our methodical prejudices and limitations.

You see, in learning to understand man in this threefold aspect we must observe that he is connected with the outer world in a three fold way His life of nerves and senses is one way in which man is related to the outer world; through all rhythmic processes he is related to it in another way. It lies in the very nature of the rhythmical processes that they cannot be considered as isolated within man, apart from the rest of the world, for they depend upon the breathing, — a process of perpetual interchange between the human body and the outer world. Again, in the metabolism there is a very obvious process of interchange between man and the outer world. Also the nerves-and-senses process

may be regarded as a continuation of the outer world into the inner man. This becomes easier to understand if the distinction is made between the actual perceptions, given to us through the senses, and the accompanying process of cognition — the forming of ideas and mental pictures. It is unnecessary here now to go into these things more deeply, for it is evident enough. In relation between man and the outer world during sense-perception the emphasis is more on the outer world, while the forming of ideas and mental pictures takes us more into the inner man. (I am referring to the bodily processes, not to the life of soul.)

Again, leaving aside for the moment the rhythmic system — breathing and blood-circulation — the metabolic system brings us to something else, which is in definite contrast to this inward-leading process from sense perception to ideation. A thorough study of the metabolic system establishes a connection between the inner metabolic processes and the functions of the human limbs. The limb-functions are connected with the metabolism.

If people would proceed more rationally than they are wont to be they would discover the essential connection between the metabolism, situated as it is more deeply within the body, and the processes by means of which we move our limbs. These too are metabolic. The actual organic functions which underlie the movements of the limbs are processes of metabolic. Consumption of material substances is what we find if we examine the organic functions here.

But we must not stop short at the metabolic process as such. There is a way in which this process leads as much from man towards the outer world, as sense-perception leads from the outer world towards the interior of the human body. (Such methods of research, which are really fundamental, need to be undertaken, otherwise no progress will be made in certain essential directions.)

What is it that is directed outward from the metabolism even as something is directed inward from sense-perception to the creating ideas and mental pictures? It is the process of fertilization. Fertilization points in the opposite direction, — from the bodily organism outward. Representing it diagrammatically (Fig.1): In sense-perception the direction is from without inward; this in — coming process of sense-perception is then ‘fertilized’ by the organism and we get the forming of ideas. (Please do not take offense at the expression ‘fertilized’; we shall soon replace, what may look like a symbolical way of speaking, by the reality it indicates.) In the metabolic process the direction is from within outward, and we get actual fertilization. In what is manifested therefore at the two poles of threefold human nature, we are led in two opposite directions.

In the middle is all that belongs to the rhythmic system. Now we may ask, what in the rhythmic system is directed outward and what inward? Here it is not possible to find such precise distinctions as between the inner metabolism and fertilization, or between perception and ideation. The processes in the rhythmic system rather merge into one-another. In the in-breathing and out breathing the process is more of a unity. It cannot be distinguished quite so sharply, yet it is still possible to say (Fig.1): As sense perception comes from outside and fertilization goes outward, so too in inspiration and expiration there is a going inward and outward. Breathing is intermediate.

Here is a true example of metamorphosis: a single entity, underlying threefold human nature, organized now in one way, now in another.

In the upward direction this can be followed to some extent physiologically. (Some of you already know what I Shall now refer to.) Observe the breathing process. The intake of air influences the organism in a certain way; namely, in in-breathing, the cerebro — spinal fluid, in which the spinal cord and brain are stepped, is pressed upward. You must remember that the brain is in fact floating in cerebral fluid, and is thus buoyed up. We should not be able to live at all without this element of buoyancy. We will not go into that now, however, but only draw attention to the fact that here is an upward movement of the cerebral fluid in in-breathing and a downward movement in out-breathing. So that the breathing process actually plays into the skull, into the head. In this process we have a real interplay and co-operation of the nerves-and-senses system with the rhythmic system.

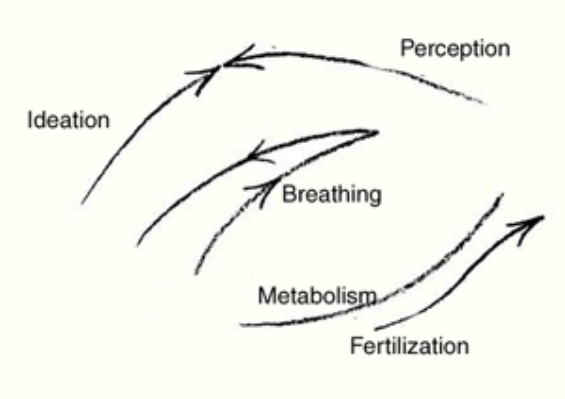

Fig. 1

You see how the organs work, to bring about what we may call metamorphosis of functions. Then we can say, however hypothetical or only as a postulate: perhaps something similar will be found as regards metabolism and fertilization. But in this realm of the body we shall less easily reach a conclusion. This is indeed characteristic of the human organism; it is comparatively easy to understand the interpenetrating relation between the rhythmic system and the nerves-and-senses system in process accessible to thought, but we cannot so easily find an evident relation between the rhythmic system and the processes of metabolism and fertilization.

Call to your aid the physiological knowledge at your disposal, and the more exactly you go into the matter the better you will perceive this. Moreover it is quite obvious why it is so. Consider the regular alternation of sleeping and waking. Through sense-perception you are open to the outer world, continuously exposed to the outer world. Then you set to work with your thinking and ideation and bring a certain order and orientation into what you see around you in your waking life. It becomes ordered through an activity which works from within outward; the orientation comes from within. Actually we can say: We confront an external world which is already ordered according to its own laws, and we ourselves bring another order into it out of our own inner being. We think about the outer world, we put together the facts and phenomena according to our own liking — unhappily, often a very bad liking! From our inner being, something is introduced into the outer world which by no means necessarily corresponds to this outer world. If this were not so, we should never fall a victim to error. Out of our own inner being comes an arbitrary remolding of the world around us.

But now, looking at the other pole of human nature, you will agree that the disordering comes from without, both in metabolism and fertilization. For it is left very largely to our own arbitrary choice and free will, how we sustain our metabolism by taking food, and even more so, how we behave as regards fertilization. But here the arbitrary element has much to do with the outer world, which in the first place is foreign to us. We do at least feel at home in the arbitrary element we introduce, out of our own inner being, into the process of perception. But we do not feel familiar with all that we bring into ourselves from the outer world. We have, for instance but a very slight idea — at least, most people have very little idea of what actually happens in our relationship with the world when we eat or drink. And as to what happens in the intervals of time between our meals, — to this we pay very little attention, and even if we did it would not help as much. Here we come into an indefinite, impalpable region, I would say. Thus at the one place of man's being we have the ordered Cosmos which extends its gulfs, as it were, in our sense organs (Fig.2). (The world ‘ordered’ must not be misunderstood, it is only used to characterize the facts; we will not lose ourselves in philosophical arguments as to whether the Cosmos is really ordered or not, we want only o characterize the given facts.) The pole is in contrast to the other, which, we are bound to admit, is an un-ordered Cosmos, considering all that comes into us from without all that we stuff into ourselves, or again, how the process of fertilization is entered into in quite irregular intervals of time and so on. Contemplating this invasion of the

metabolism by the outer world, we must admit that we are here confronted by an unordered Cosmos — un-ordered at least to begin with, so far as we are concerned.

And now we may put the question — from the more general aspects of the theory of human knowledge: How and to what extent are we really connected with the starry Heavens? In the first place, we see them. But you will have a vivid feeling by this time of the uncertainties which assail us when we being to think about the starry Heavens. Not only have the men of different ages felt convinced of the truth of the most diverse astronomical world — systems. As we saw yesterday, we have to face the fact that we cannot contain the totality of the starry Heavens in the mathematical and mechanical forms of thought in which we feel most secure.

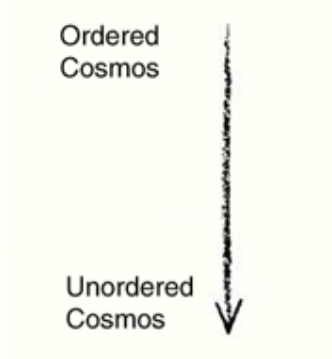

Fig. 2

Not only must we admit that we cannot trust to mere sensory appearances as regards the Heavens, but we must recognize that when we take our start from what we see and then work upon it with the life of thought, which, as we saw, belongs more to the inner man,we cannot ever really get at this world of stars. It is the truth, it is no mere comparison to say: The starry Heavens only present themselves to us in their totality — a relative totality, of course — through sense perception. Taking our start from sense-perception, when we as man try to go farther inward, to understand the starry Heavens, we feel somewhat foreign to them. We get a strong feeling of our inadequacy. And yet we feel that something intelligible must be there in the phenomenon which we behold.

Outside us, then , is the ordered Cosmos; it only presents itself to our senses. It most certainly does not at once reveal itself to our intellectual understanding. We have this ordered Cosmos on the one hand; with it, we cannot enter into man. We try to lead on from outer sense-perception of the Cosmos towards the inner man — the life of thought and ideation — and find we cannot enter. We must admit: Astronomy will not quite go into our head. This is not said in the least metaphorically. It is a demonstrable fact in the theory of knowledge. Astronomy will not go into the human head; it simply will not fit there.

What do we see now at the other pole — that of the unordered Cosmos? Let us but look at the facts; we do not want to set up theories or hypotheses, but only to see the facts clearly.

Look for what is in contrast, in the outer Universe to the astronomical domain, and in man to the processes of perception and ideation (the continuation of the ‘ordered Cosmos’ into man). In man you come into the realm of metabolism and fertilization — and Astronomy (Fig.2) and look downward in an analogous way, into what realm are you led? You are led into Meteorology — all the phenomena of the outer world once more, relating to Meteorology. For if you try to understand meteorological phenomena in terms of ‘natural law’, the amount of law you can bring in is to the ordered Cosmos of Astronomy in just the same proportion as is the temperamental region of metabolism and fertilization in man to the realm of sense perception, into which the whole starry Heaven sheds its light, — which only begins to get into disorder in our own inner life, namely in our forming of ideas.

If therefore we regard man not as an isolated being, but in connection with the whole of Nature, then we can place him into the picture in the following way. Through his head, he takes part in the astronomical, through his metabolism in the meteorological domain. Man is thus interwoven with the Cosmos on either hand.

Let us here add another thought. Yesterday we spoke of those processes which may be looked upon as an inner organic imagining of Moon-events, namely the processes in the female organism. In the female organism there is something like an alternation of phases, a succession of events, taking their course in 28 days. Although, as things are now, these events are not at all dependent on any actual Moon-events, yet they are somehow an inner reflection of the moon. I also drew your attention to the following psycho-physiological fact. If we really analyze human memory and take into account the underlying inner organic process, we cannot but compare it with this functioning of the female body. Only that in the latter the bodily nature is taken hold of more intensely than it is when holding fast in memory some outer experience which it has undergone. What comes to expression in these 28 days as a result of erstwhile our impressions is no longer contained within the individual life between birth and death, whereas the experiencing of outer events and the memory of them comes into a shorter period and takes its course between birth and death, within the single life of the individual. Considered in their psychological-physiological aspect, the two processes are however essentially the same — a functional reexperiencing of an external process or event. (In my 'Occult Science' I clearly hinted at this kind of experience in relation to the outer world.)

Now, study the functions of the ovum before fertilization and you will find that they are entirely involved in this 28-day inner rhythm; they belong to this process. But as soon as fertilization takes place, the processes in the ovum immediately fall out of this inner rhythmic life of the human being. A mutual relation with the outer world is at once established. Observing the process of fertilization, we are led to see that what is happening in the ovum from then onward no longer has to do with mere inner processes in the human body. Fertilization tears the ovum out of the purely inner organic process and leads it over into the realm of those processes which belong in common to the inner being of man and to the Cosmos, — a realm in which there are no barriers between what takes place within man and in the Cosmos. Therefore, what occurs after fertilization, — all that happens in the forming of the embryo, — must be studied in connection with external cosmic events, and not merely in terms of developmental mechanisms within the ovum itself in its successive stages.

Think what this means. All that goes on in the ovum before fertilization is, so to speak, within the domain of the human being's own inner organic process. But in what happens after fertilization and is brought about thereby — the human being opens himself to the Cosmos. Cosmic influences here prevail.

Thus on the one hand we have the Cosmos working in upon us up to the point where the life of ideas begins. We have, in sense — perception, a mutual relation, between man and the Cosmos. We investigate this relation, for example, by means of the laws of perception. The physiology of the senses and so on. The way in which we see an object must be investigated through such laws. Suppose we watch a railway-train traveling past us. We see the whole movement lengthwise. If, however, we are at a point directly in front of the train far enough away — however fast the train is going, we see it as if it were stationary. Pictorially, therefore, what takes place in us depends on the relation of the cosmos to us. We are in the midst of pictures and we ourselves belong to the picture. However, we become entangled in something chaotic, — for ultimately, our world systems are chaotic, — if we try to draw conclusions as to the real events from what we see externally.

On the other hand, in regard to fertilization, man is involved not in pictorial but in real cosmic processes.

Thus at the one role man is immersed in the Cosmos in a pictorial, and at the other in a real way. The very thing that eludes him when he looks out into the Cosmos, works in upon him when he undergoes the process of fertilization. Here therefore something, in itself a whole, is drawn apart into

two members. In the one case a mere picture is before us and we cannot strike through to the reality. In the other the reality confronts us; through it a new man comes into being. But it does not become clear picture; it remains for us as devoid of law as do the manifestations of the weather, or meteorological conditions generally. Here we are face to face with a duality — here are two poles. From either side we receive half thrilled. It is as though we received the picture from the one side and the reality which underlies it from the other.

You see, the way man confronts the world is not as simple as one might assume in saying: The sensory picture of the world is given; now let us devise the reality by philosophical methods. This problem of finding the underlying reality in sense-perception is, of course, fundamental in the philosophic theory of cognition. But man is curiously balanced between the picture and reality in quite other ways than by mere philosophic speculation.

Now in the course of world-evolution, men have already tried to approach this secret through an experience of the intermediary realm: in-breathing and out-breathing. The ancient Indian wisdom which, as I often say, it would be wrong for us to imitate today — proceeded more or less instinctively from the following hypotheses. Sense-perceptions are of no use in the striving for reality; nor are the sexual processes or those of fertilization, for they give no clear picture. Therefore, let us keep to the middle region, which is metamorphosed at one time towards picture-forming and at another time towards reality. We must keep to the middle region, for through it the approach to reality and yet at one and the same time to the picture must in some way be possible. This is why the special breathing exercises of the Yoga system were perfected by the wisdom of Ancient India. Men sought to reach reality by experiencing the breathing process consciously, thus grasping at the same time both picture and reality. And if one asks why this should be, the answer is given: Breathing unites picture and reality. (The answer may be more or less instinctive, though not entirely so, as you can see if you will study, in the Indian philosophy itself, how this strange system of breathing-exercises arose.) Breathing unites picture and reality. The picture is experienced in its relation to the reality, if once the breathing process is lifted out of the unconscious into consciousness. We shall never understand what thus appeared in the historic evolution of mankind, unless we regard it from the point of view of the inner physiology of man. Looking at it in this light, you can say: There was a time when men sought to comprehend reality by turning to man himself. For pictures of the world, we have the senses; for the reality, something quite different. Therefore men turned to that part of the world human being which is neither shutoff in finished pictures, nor on the other hand in the mere experiencing of reality; they turned to what is not yet differentiated or divided — to the breathing process. And in so doing, they brought man into the Cosmos. They did not contemplate a world separate from man like the world of our Natural Science; they beheld a world for which man, as rhythmic man, became a real organ of perception. This world, they said, can be grasped neither by the nerves-and-senses man, nor by the metabolic man. In his life of nerves and senses, man becomes conscious in such a way that what presented itself to nerves and senses is thinned out to a mere picture; in the metabolism, reality meets him in such a way as not to be raised into consciousness at all. The interweaving of the real but unconscious experience with what is thinned out to a picture was sought by the wise men of ancient India in the regulated breathing process. Nor shall we ever understand the ancient cosmic systems, previous to the Ptolemaic, till we are able to divine how the Universe appears to man when in this was a synthesis, however undifferentiated, is achieved between the process of cognition on the one hand, and on the other the intense realty of the reproduction-process.

Consider now from this point of view the teachings about the creation of the world which are to be met with particularly in the Bible: teachings which, as things are today, are not so easy to see through. Consider the Bible story of the Creation, particularly as interpreted by those who still had the old traditions. Fundamentally, the Biblical story of Creation can only be understood if we are able to combine the genesis of the world which we derive by looking at the outer Universe, with that which we derive by Embryology. What is set forth in the Book of Genesis is in fact compounded of Embryology and of what is seen in the outward glory of the sense world. Hence the repeated attempts to interpret the Biblical story of Creation, even word for word, by embryological facts. Truly, it calls for such interpretation.

I introduced this today, my dear friends, for quite a definite reason.

You see, if our present studies — intended, as they are, to form a bridge between the external Science of today and Spiritual Science — are to have any meaning at all, we must first acquire a quite definite feeling and must permeate ourselves with this feeling otherwise we can get no further. We must become able to feel that certain modern ways of thought are superficial and external, — to feel this in a thoroughly deep way. We must learn to see the superficiality, on the one hand, of setting up pictures of the Universe which only try to make some slight corrections in the Copernican System, and on the other hand, of researching into the embryonic life in the ways which are customary today. One might say that Nietzsche's dictum: "The world is deeply thought and wrought; more deeply than the passing day", proceeded from such a feeling. The impulses must be acquired not to seek explanations in the mere superficial acceptance of what presents itself directly, even if it be to the enhanced sight of telescope or microscope or X-ray apparatus. We must learn to have respect for explanations of another nature, aspiring to other faculties of knowledge, such as were sought by the old Indian sages in the Yoga System, so as to penetrate into reality and find the means of forming an adequate picture of reality.

Since we have now outgrown the Yoga system, we must feel impelled towards a new way of penetrating into the Universe by processes which still remain to be developed — which are not to be derived so simply from the habitual methods of today. For man is placed in the midst between the picture of the world, — a picture which presents itself to him in an overwhelmingly forceful way in the starry Heavens, the secrets of which will never be disclosed through the mere intellectual faculties, — and what meets him with ever — changing mood and temperament in the processes of reproduction, by virtue of which the human race exists. Into the midst of this great whole which is thus separated for him into two halves, man is placed. to find a connection between the two, he must look for a way of spiritual development, even as he did in an older form in the Yoga system, — a form no longer possible today.

Astronomy, practiced as hitherto, will never lead to a grasp of reality; it will only give us pictures. And Embryology, though in this realm we seize reality, will no enable us to penetrate the reality with ideas and mental pictures. Astronomical pictures of the world are poor in reality; embryological pictures are poor in idea — we fail to penetrate the facts with clear ideas. Thus in the theory of knowledge too we must approach the human being as a whole, instead of merely indulging in philosophical and psychological speculations about sense-perception. We must take our start from the whole of man. We must learn how to place man as a whole into the Universe. That is our task today.

It is very evident today, how on the one hand in Astronomy the ground of knowledge is being lost. And it is evident how on the other hand in Embryology, where knowledge fails to reach the well-springs of reality, all that results is a mere talking round and round the given facts, whether in terms of the biogenetic law or of developmental mechanisms. Amplification of our fundamental methods is quite evidently needed in both of these directions.

I had to put all this before you, so that we might understand each other better in what follows. For it will help you see that it would be no use if I were simply to add another formal picture of the Universe to the existing ones, although admittedly that is the kind of thing which people nowadays desire.

Lecture VI
Stuttgart, January 6, 1921

My Dear Friends,

You will have seen, from what has been said so far, that in the explanation of natural phenomena we need to find a path leading beyond the intellectually mathematical domain. That we do not dispute the justification of a mathematical approach is implicit in the whole spirit of these lectures. But we were able sharply to define the point beyond which it is impossible to go with mathematical thought-forms, in the celestial spaces on the one hand, and in the realm of embryology on the other. We must hew out a path to other methods of cognition. It is the purpose of these lectures to show the scientific need of other methods.

I shall try to show that what is looked for nowadays merely by gazing outward into celestial space — whether with the unaided eye or with the help of optical instruments — needs to be put on a far wider basis, so that not only a part but the whole of man becomes the 'reagent' for a deeper penetration of the Heavens. Today I shall try, if not to prove, at least to indicate the validity of such a widening of method, by approaching the problem from quite another side. It may seem paradoxical in relation to our present theme, but the reason will soon become plain.

In studying the evolution of mankind on Earth we must surely find something within human evolution itself to guide us to the essential source of the celestial phenomena. For otherwise we should be assuming that what goes on in the Universe beyond the Earth is without influence on man, — on human evolution. No-one will make such an assumption, although admittedly the influences may be over-estimated by some and under-estimated by others. It will therefore be plausible — at least from a methodic point of view — to put the question: 'Can we find anything in the evolution of mankind itself to indicate ways of access to the secrets of celestial space?' Asking this question, we will take our start, not from Spiritual Science, but from the facts which anyone can gather for himself by empirical, historical research.

Looking back in the evolution of mankind in the realm where human thoughts, the human faculties of knowledge find expression, where, so to speak, the relation of man to the world takes on the most highly sublimated forms — we are led back, to begin with (as you may gather from my 'Riddles of Philosophy'), only a few centuries into the past. Indeed I have often pointed to a certain moment during the 15th century, one of the most essential in the more recent phase of human evolution. The indication is of course approximate. We have to think of the period about the middle of the Middle Ages. Needless to say, we are referring only to what was going on within civilized mankind.

It is not generally seen clearly or sharply enough, how deep and incisive a change was then taking place in human thought and cognition. There has unfortunately for some time been a downright aversion — among philosophers especially — to a real study and appreciation of the epoch in European civilization which may be called the Age of Scholasticism. During that age, deeply significant questions came to the surface of man's life of knowledge. It one goes into them deeply enough, one feels that these questions did not merely spring from the realm of logical deduction — the form in which the Middle Ages used to clothe them — but from the very depths of man's being.

One need only recall what then became a fundamental question in human knowledge — the question of Nominalism and Realism. Or again, what it betokened in the spiritual development of Europe that attempts were made to prove the existence of God. There was for instance the so-called ontological proof of the existence of God. From thought itself — from the pure concept — men wanted confirmation of God's existence. Think what it means in the whole evolution of human knowledge. Something was stirring in the inmost depths of human being; in the philosophical deductions of the time it only found fully conscious expression. Men were perplexed as to whether the

concepts and ideas, which man forms and puts into words, in some way stand for a reality, or whether they are merely formal summarizations of the external sensory data. The Nominalists regarded the general concepts which man creates for himself as a mere formal summary, having no significance for the external reality but only helping man to find his way about — to orientate himself in an otherwise confusing outer world. The Realists (an expression used in a rather different sense than today) declared that something real is to be found in general or universal concepts, — that in these concepts man in his inner life takes hold of something real, — that they are no mere convenient generalizations or abstractions from the world.

Often in more public lectures I have related how my old friend Vinsenz Knauer — a latter-day scholastic, though he would not have claimed to be one — showed himself very clearly, in his interesting work "The Central Problems of Philosophy, from Thales to Robert Hamerling", to be thoroughgoing Realist. The Nominalists, he said, assert that the concept 'lamb' is nothing but a convenient generalization arising in the human mind; so too the concept 'wolf'. Matter is only put together in a different way in the lamb and in the world. We only summarize it in the convenient abstraction, 'lamb' or 'wolf' as the case may be. Well, he suggested, try for some time to keep a wolf away from all other food and give it only lambs to eat, after the necessary lapse of time the matter in the wolf will be nothing but lamb, and yet it will not have lost its wolfishness. Therefore the wolf-nature, expressed in the general concept 'wolf' must be something real.

Now the fact that the so-called 'ontological' proof of God's existence could arise at all, bears witness to a deep and thorough going change then taking place in human nature. Quite a short time before, it simply would not have occurred to anyone within European culture to want to prove God's existence, for this was felt to be self-evident. Only when this feeling was no longer alive in men, did they begin to crave for proof. If you have living inner certainty about a thing, you do not want to prove it. But at that time something was slipping away from man, which until then had been alive in him quite as a matter of course, and the human spirit was thus led into quite other channels — quite other needs. I could adduce many another example, showing precisely at the highest levels of thought and knowledge (though you may take the word 'highest' with a grain of salt) what a deep stirring and rumbling was going on in human nature during that period of the Middle Ages.

Now we can surely not deny that there must be some connection between what is going on in the life of mankind and the phenomena in the Heavens beyond the Earth. In the most general sense, we must assume that there is some connection; what it is in detail, we shall discover in due course. Hence we may ask — we want to proceed very carefully, so we need only ask — 'How were these inner experiences which man on Earth was undergoing at that time, connected with the evolution of the Earth-plant altogether?', — a question which may obviously lead us into realms beyond the earth. Was it perhaps a special moment in the evolution of the Earth a such? Is there anything that we can point to as a more definite criterion of what this moment was in human evolution?

We can indeed point to something of significance in this connection. There was another time which made a deep incision in the name regions of the Earth where in the Middle Ages these events were taking place in the most highly sublimated realm of human life the spiritual life of thought. The medieval time, when this deep moving and stirring of humanity took place, lies in the very midst between two end-points, as it were, in the scale of time. For European regions these 'end-points' do not represent the kind of times in which intense activity of human life and culture would be possible at all. In effect, if from this medieval moment, which I will call A (Fig. 1), we go backward and forward an equal length of time into a fairly distant past and future, we come to points of time representing a certain barrenness and death of civilization in the very regions where this deep stirring of human life was going on in the 13th, 14th, and 15th centuries. About 10,000 years forward and 10,000 years back from this moment (A in Figure 1) we reach the maximum development of the Ice Ages in these very regions Ice Ages certainly would not allow of any outstanding development in human life and culture.

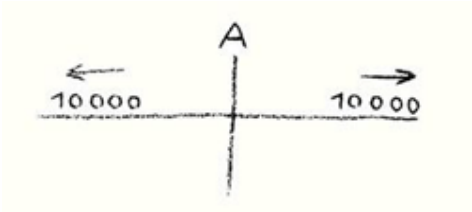

Fig. 1

Surveying therefore the evolution of these European regions we find an Ice Age — a laying-waste of civilization — 10,000 years before the Christian era, and we should find the same again 10,000 years after this time. The deep stirring of human life, of which we have been speaking, happened midway between two such barren epochs.

As I said just now, there is a certain reluctance to pay attention to this period in the development of philosophy — the 13th and 14th centuries; — it is not seen clearly and accurately for what it is. Yet if one has a feeling for the evolution of the life of knowledge in mankind, one is aware that to this day our philosophic history is influenced by the after-effects of what was stirring and rumbling in the life of mankind at that time. It showed itself in other domains of civilization too; it only came to expression most clearly and symptomatically in this phase of development of the life of thought and knowledge.

Now as you know, this phase of development — appearing about the middle of the Middle Ages — was an incisive one in European civilization. I have often spoken of it in anthroposophical lectures. It was an incision. Something was changed in the whole trend of human evolution. It had been beginning long before — in the 8th century B.C. We may describe it as a most intense development of human intellectuality.

Since then, in the life and civilization of mankind, we have been looking especially at the development of Ego-consciousness. All aberrations and all wisdom gained in the general life of humanity since that medieval time are really due to this Ego-development to the ever-growing elaboration of the consciousness of "I" in man. The consciousness of the ancient Greeks and even of the Latins (both the ancient Latins and their descendants, the Latin peoples of today) did not lay so much stress on the Ego. Even in language for the most part, in grammar and syntax, they do not pronounce the "I" so outspokenly, but still include it in the verb. The "I" is not yet so blatantly set forth. Take Aristotle and Plato, and above all the greatest philosopher of antiquity, Heraclitus. Throughout their work the Ego is not yet so prominent. The way in which they take hold of the world-phenomena with the intellectual reasoning principle is as yet rather more selfless. (Please do not over stress this, but in a relative sense the word 'selfless' may be used.) There is not yet so sharp a dissociation of the self from the world-phenomena as there tends to be in the new age — the Age of Consciousness in which we are now living.

Going still farther back — beyond the 8th century BC — we come into the Egyptian and Chaldean Age as I have called it (you will find the details in my "Occult Science"). Once again, the condition of the human soul was different. During this age — which like the others, lasted for over 2,000 years — man was not yet relating external phenomena to one-another by intellectual reasoning at all. He apprehended the world — the Heavens too — rather in feeling and direct sensation. It is mistaken and fruitless to approach what is still extent of the Astronomy of Egypt and Chalden with present-day intellectual judgments — the kind of judgment which we ourselves have inherited from the Graeco-Latin Age. We must achieve a certain metamorphoses or soul so as to enter into the quite different soul-condition then prevailing, where man took hold of the world in simple feeling and sensation (where the concept was not yet separated from the sensation).

Even in the realm of actual sensations or sense-impressions — as can be shown historically and philologically — they attached no great importance to the precise description of the blue and violet

shades of color, whereas (they had a very keen sensation of the red and yellow regions of the spectrum. Indeed the sensation of the dark colors can be seen to have arisen simultaneously with the capacity for intellectual concepts.

The Egypto-Chaldean Age — from 747 B.C. about 2160 years into the past, — takes us to the beginning of the third millennium BC. Still earlier, say in the fourth or fifth millennium BC, we come into an age when man's whole outlook and mode of perception were so different from ours today that it is hard for us, without recourse to spiritual-scientific methods, to transplant ourselves at all into the way in which the man of that time was the world around him. It was not only a feeling and sensing, — it was a living with the outer happenings, being right in them. Man felt himself a part and member of all Nature around him, much as my arm, if it were conscious, would feel itself a member of my body.

Here therefore was an altogether different trend and quality in man's relation to the world. And if we go still farther back, we find this union of man with the surround world even more enhanced. In those very early times, civilizations were only able to develop where special geographical conditions made it possible. I mean the time described in my “Occult Science” as the Ancient Indian civilization — much earlier than the culture of the Vedas, which was but a later echo of it. The Ancient Indian epoch comes very near to the time when glacial conditions prevailed in our regions of the Earth. A culture like the Ancient Indian could only develop when such climatic conditions, more or less, as we enjoy in the Temperate zone today, extended to what is now the Equator. You can deduce it simply from the relative advance or retreat of the ice; tropical conditions did not come about in India until a must later time, when in more northerly regions the ice had receded.

We see therefore how the inner evolution of mankind undergoes modifications hand in hand with changing terrestrial conditions — changing conditions, that is to say, on the Earth's surface. Only those who take a very short-term view of mankind's evolution upon Earth will imagine that the scientific ideas we entertain today have any absolute validity — that we have now at last got through to the scientific truth, so to speak. To anyone who looks more deeply into these regions of the Earth which are today enjoying certain forms of cultural and spiritual life will at some future time inevitably be laid waste again; they will be desolate once more. From the past length of time you may reckon out how long ahead it will be till a new glacial age overtakes our present civilization. Moreover assuming that we can find some connection between the celestial phenomena and these facts of earthly evolution — the successive Ice-ages and the mid-point between them — this will lead on to a further insight. That which take place on Earth in the most highly sublimated realms of cultural like — in the life of thought and knowledge — will be related now not only to these changing conditions on the Earth itself, but to conditions in the outer Cosmos. Purely empirical reflection shows that man is what he is by virtue of conditions on the planet Earth and in the Universe beyond.

Once more then taking the facts empirically as is usual in Science, only with a somewhat wider range, our vision is extended until we recognize such a relationship as we have just been describing. Now in a sense, even in present time we can perceive how the quality and trend of human spiritual life is brought about by the relation between the Earth and the celestial bodies. In an earlier lecture it was pointed out how different the spiritual configuration of mankind tends to be in Equatorial and in Polar regions. Investigating this more closely, the different relation of the Earth to the Sun proves to be the determining factor. It makes man in the Polar regions less free of his bodily nature. Man in the Polar regions is less able to lift himself out of the bodily organism, — to pain free use and manipulation of his life of soul (As to the different mutual relations of Earth and Sun, there will be more in it than that, as we shall find in due course; but to begin with we can take our start from the conventional notions.)

We need only picture to ourselves how differently the men of Polar regions are taken hold of by something which in ourselves keeps more in the background. We of the Temperate zone have the quick alternation of day and night. Think how long this alternation becomes as you approach the Polar zone. It is as though the day were to lengthen out into a year. I told you of what works in the little child, deep in the bodily nature from year to year, from birth to the change of teeth, and of how the independent working of the life of soul, given up as it is to the quicker rhythm of the day, gradually

frees and detaches itself from this more bodily working. This is not possible to the same extent in Polar regions. It is the yearly rhythm which will there tend to make itself felt. The emphasis is more on the bodily side. The human being will not wrest himself free to the same extent from what works within the body.

Think now of the scanty relics that have been preserved from the civilization of very early times, — that have survived the Ice Age. Then you will see that there were times in which a kind of 'Polarization' (giving the word its proper meaning in this context) extended right across the present Temperate zone, so that conditions were prevailing here not unlike those in the present Polar regions. You can use this comparison for what was working in the Ice Age; you can truly say: What is now pressed back towards the North Pole, extended then over a considerable part of the Earth. (Please keep this free of present-day explanations and ideas, for otherwise the pure phenomenon will be obscured. Take only the pure phenomenon as such.)

Conditions on the Earth today are such that we have the three types; the human beings of the Tropical, the Temperate and the Polar zones respectively. Of course they influence each other, so that in outer reality the phenomenon does not appear quite so purely. Nevertheless, what you here have in a spatial form — you find it again in time as you go backward. Going back in time, we come to a 'North Pole', as it were, in time — in the history of civilization. Going forward, we come to a Pole again. Remembering that the Polar influence on man is connected with the mutual relations between Earth and Sun. We must conceive that the change which has taken place since the Ice Age — the de-polarization, so to speak — is connected with a changed relation between Earth and Sun. Something must have happened as regards the mutual relation between Earth and Sun. What was it then? The facts themselves suggest the question. What is the source of this in the celestial spaces?

Consider it more nearly. Of course these things will be different in the Northern and Southern hemispheres, but the facts remain. We shall at most have to extend our picture, adapting it to the real facts. We can only take our start from the empirically given data. What is revealed then, if we approach the phenomena without preconceived ideas? The Earth and the events on Earth appear as an expression of cosmic happenings — cosmic happenings which manifest themselves in certain rhythms. Something that showed itself about the tenth millennium before the origin of Christianity, will show itself again about the eleventh millennium after. What is in between, will also in a sense be repeated. What we here have between the two Ice Ages, will undoubtedly have been there before — in former cycles. It is a rhythm; our attention is drawn to a rhythmic process.

And now look out into the celestial phenomena. To emphasize one fact especially, which I have often pointed to in my lectures, you have the following. (I will only characterize it roughly.) You know that the vernal point — where the Sun rises in spring-time gradually moves through the Ecliptic. Today the vernal point is in the constellation of Pisces; before, it was in Aries; still earlier in Tauraus, — that was the time of the cult of the Bull among the Egyptians and Chaldeans. Still earlier, it was in the constellation of Gemini, and then in Cancer; in Leo. This already brings us very nearly to the last Ice Age. Thinking it through to a conclusion, we know that the vernal point goes all the way round the Ecliptic, and that the time it takes is called the Platonic Year — the great Cosmic Year, lasting approximately 25,920 years.

A whole number of processes are comprised in these 25,920 years, involving among other things this rhythmic alternation on the Earth; Ice Age., intermediate period, Ice Age, intermediate period, and so on. At the time we spoke of, when there was that deep stirring of the spiritual life in mankind, the vernal point was entering the sign of Pisces. In the Graeco-Latin Age it had been in the sign of Aries, previous to that in Taurus, and so on. We get back to Leo or Virgo, more or less, during the time when glacial conditions prevailed over the greater part of Europe and in America too. Looking into the future, there will be another Ice Age in these regions when the vernal point reaches the sign of Scorpio. This rhythm is contained within what takes its course in 25,920 years. Although admittedly of vast extent, it is a true rhythm none the less.

Now as I have often mentioned, this rhythm is reminiscent — purely numerically — of another rhythm. If it is simply a question of rhythms and the rhythms are expressible in numbers, if the numbers are the same the rhythms too are the same. You know that the number of breaths man takes — in breathing and out breathing — is approximately 18 to the minute. Reckon out the number of breaths in a 24-hour day and you get the same number as before — 25,920. Man therefore shows in his daily life the same periodicity, the same rhythm, as is revealed by the movement of the vernal point in the great Cosmic Year. Now it is in the day that man shows this rhythm. A day therefore, with respect to breathing, corresponds to the Platonic Year. The vernal point — connected as it is with the Sun — goes round apparently in 25,920 years. But there is also the apparent movement of the Sun through the 24 hour day, while man is taking 25,920 breaths. It is the same picture here as in the great Universe. If then there were a Being who breathed in and out once a year (a simple-minded hypothesis no doubt, but we will use it for comparison), — such a Being, if living long enough, would undergo in 25,920 years the same process as man does in a day. Man reproduces, as it were in miniature, what is manifested in the great cosmic process.

These things make little impression on the people of today, for they are not accustomed to look at the qualitative aspect of the world. Quantitatively, the mere rhythm appears less important. Therefore the scientists are out to find other relations between numbers than these that find expression in pure rhythms. They pay less heed to the latter: But in the epochs when man experienced more nearly the relation between himself and the Universe — when he felt himself more immersed in the phenomena of the Cosmos — these things made a deep impression on him. As we go back in the history of mankind — beyond the second or third millennium BC — we find great attention paid to the Platonic Year. I mentioned yesterday not to explain it, but by way of illustration — the ancient Indian Yoga system. Man entered deeply into a living inner experience of the breathing process, trying to make it conscious. In doing so there dawned upon him this relation between the rhythm that goes on in man — breathed, as it were, into man in a concentrated and contracted form — and the phenomena of the great Universe. Therefore he spoke of his own in- and out-breathing and of the mighty in- and out-breathing of Brahma, a single breath spanning an entire year, for which 25, 920 years are a day — a day of the Great Spirit.

I do not wish to make an unkind remark, my dear friends, but we do here begin to get some notion of the great distance which men at one time felt between themselves and the Spirit of the Macrocosm whom they revered. Man felt himself about as far beneath the Spirit of the Macrocosm as a day is beneath 25,920 years. It was indeed a great Spirit — a very great Spirit — whom man conceived in this way and whose relation to himself he experienced with due modesty. It would not be uninteresting to compare how great is the distance often felt by modern man between himself and his God. Does he not often conceive the Deity as little more than a slightly idealized human being?

This may not seem very relevant to our subject, but in fact it is. If we want to develop real means of knowledge in this sphere, we must find our way from what is merely calculable into quite other realms. Indeed our study of Kepler's Laws and all that followed from them showed how our very calculations, leading as they do to incommensurable numbers, impel us of their own accord into a realm beyond mere calculation.

Lecture VII
Stuttgart, January 7, 1921

My Dear Friends,

You will have seen how we are trying in these lectures to prepare the ground for an adequate World-picture. As I have pointed out again and again, the astronomical phenomena themselves impel us to advance from the merely quantitative to the qualitative aspect. Under the influence of Natural Science there is a tendency, in modern scholarship altogether, to neglect the qualitative side and to translate what is really qualitative into quantitative terms, or at least into rigid forms. For when we study things from a formal aspect we tend to pass quite involuntarily into rigid forms, even if we went to keep them mobile. But the question is, whether an adequate understanding of the phenomena of the Universe is possible at all in terms of rigid, formal concepts. We cannot build an astronomical World-picture until this question has been answered.

This proneness to the quantitative, abstracting from the qualitative aspect, has led to a downright mania for abstraction which is doing no little harm in scientific life, for it leads right away from reality. People will calculate for instance under what conditions, if two sound-waves are emitted one after the other, the sound omitted later will be heard before the other. All that is necessary is the trifling detail that we ourselves should be moving with a velocity greater than that of sound. But anyone who thinks in keeping with real life instead of letting his thoughts and concepts run away from the reality, will, when he finds them incompatible with the conditions of man's co-existence with his environment, stop forming concepts in this direction. He cannot but do so. There is no sense whatever in formulating concepts for situations in which one can never be.

To be a spiritual scientist one must educate oneself to look at things in this way. The spiritual scientist will always want his concepts to be united with reality. He does not want to form concepts remote from reality, going off at a tangent, — or at least not for long. He brings them back to reality again and again. The harm that is done by the wrong kinds of hypothesis in modern time is due above all to the deficient feeling for the reality in which one lives. A conception of the world free of hypotheses, for which we strive and ought to strive, would be achieved far more quickly if we could only permeate ourselves with this sense of reality. And we should then be prepared, really to see what the phenomenal world presents. In point of fact this is not done today. If the phenomena were looked at without prejudice, quite another world-picture would arise than the world-pictures of contemporary science, from which far-fetched conclusions are deduced to no real purpose, piling one unreality upon another in merely hypothetical thought-structures.

Starting from this and from what was given yesterday, I must again introduce certain concepts which may not seem at first to be connected with our subject, though in the further course you will see that they too are necessary for the building of a true World-picture. I shall again refer to what was said yesterday in connection with the Ice-ages and with the evolution of the Earth altogether. To begin with however, we will take our start from another direction.

Our life of knowledge is made up of the sense-impressions we receive and of what comes into being when we assimilate the sense-impressions in our inner mental life. Rightly and naturally, we distinguish in our cognitional life the sense-perceptions as such and the inner life of ‘ideas’ — mental pictures. To approach the reality of this domain we must being by forming these two concepts: That of the sense-perception pure and simple, and of the sense-perception transformed and assimilated into a mental picture.

It is important to see without prejudice, what is the real difference between our cognitional life insofar as this is permeated with actual sense-perceptions and insofar as it consists of mere mental picture. We need to see these things not merely side by side in an indifferent way; we need to recognize the subtle differences of quality and intensity with which they come into our inner life.

If we compare the realm of our sense-perceptions — the way in which we experience them — with our dream-life, we shall of course observe an essential qualitative difference between the two. But it is not the same as regards our inner life of ideas and mental pictures. I am referring now, not to their content but to their inner quality. Concerning this, the content — permeated as it is with reminiscences of sense-perceptions — easily deludes us. Leaving aside the actual content and looking only at its inner quality and character — the whole way we experience it, — there is no qualitative difference between our inner life in ideas and mental pictures and our life of dreams. Think of our waking life by day, or all that is present in the field of our consciousness in that we open our senses to the outer world and are thereby active in our inner life, forming mental pictures and ideas. In all this forming of mental pictures we have precisely the same kind of inner activity as in our dream-life; the only thing that is added to it is the content determined by sense-perception.

This also helps us realize that man's life of ideation — his forming of mental pictures — is a more inward process than sense-perception. Even the structure of our sense-organs — the way they are built into the body — shows it. The processes in which we live by virtue of these organs are not a little detached from the rest of the bodily organic life. As a pure matter of fact, it is far truer to describe the life of our senses as a gulf-like penetration of the outer world into our body (Fig. 1) than as something primarily contained within the latter. Once more, it is truer to the facts to say that through the eye, for instance, we experience a gulf-like entry of the outer world. The relative detachment of the sense-organs enables us consciously to share in the domain of the outer world. Our most characteristic organs of sense are precisely the part of us which is least closely bound to the inner life and organization of the body. Our inner life of ideation on the other hand — our forming of mental pictures — is very closely bound to it. Ideation therefore is quite another element in our cognitional life than sense-perception as such. (Remember always that I am thinking of these processes such as they are at the present stage in human evolution.)

Fig. 1

Now think again of what I spoke of yesterday — the evolution of the life of knowledge from one Ice-Age to another. Looking back in time, you will observe that the whole interplay of sense-perceptions with the inner life of ideation — the forming of mental pictures — has undergone a change since the last Ice-Age. If you perceive the very essence of that metamorphosis in the life of knowledge which I was describing yesterday, then you will realize that in the times immediately after the decline of the Ice-Age the human life of cognition took its start from quite another quality of experience than we have today. To describe it more definitely; whilst our cognitional life has become more permeated and determined by the senses and all that we receive from them, what we do not receive from the senses — what we received long, long ago through quite another way of living with the outer world — has faded out and vanished, ever more as time went on. This other quality — this other way of living with the world — belongs however to this day to our ideas and mental pictures. In quality they are like dreams. Fro in our dreams we have a feeling of being given up to, surrendered to the world around us. We have the same kind of experience in our mental pictures. While forming mental pictures we do not really differentiate between ourselves and the world that then surrounds us; we are quite given up to the latter. Only in the act of sense-perception do we separate ourselves from the surrounding world. Now this is just what happened to the whole character of man's cognitional life since the last Ice-Age. Self-consciousness was kindled. Again and again the feeling of the “I” lit up, and this became ever more so.

What do we come to therefore, as we go back in evolution beyond the last Ice-Age? (We are not making hypotheses; we are observing what really happened.) We come to a human life of soul, not only more dream-like than that of today, but akin to our present life of ideation rather than to our life in actual sense-perception. Now ideation — once again, the forming of mental pictures — is more closely bound to the bodily nature than is the life of the senses. Therefore what lives and works in this realm will find expression rather within the bodily nature than independently of the latter. Remembering what was said in the last few lectures, this will then lead you from the daily to the yearly influences of the surrounding world. The daily influences, as I showed, are those which tend to form our conscious picture of the world, whereas the yearly influences affect our bodily nature as such. Hence if we trace what has been going on in man's inner life, as we go back in time we are led from the conscious life of soul deeper and deeper into the bodily organic life.

In other works; before the last Ice-Age the course of the year and the seasons had a far greater influence on man than after. Man, once again, is the reagent whereby we can discern the cosmic influences which surround the Earth. Only when this is seen can we form true ideas of the relations — including even those of movement — between the Earth and the surrounding heavenly bodies. To penetrate the phenomena of movement in the Heavens, we have to take our start from man — man, the most sensitive of instruments, if I may call him so. And to this end we need to know man; we must be able to discern what belongs to the one realm, namely the influences of the day, and to the other, the influences of the year.

Those who have made a more intensive study of Anthroposophical Science may be reminded here of what I have often described from spiritual perception; the conditions of life in old Atlantis, that is before the last Ice-Age. For I was there describing from another aspect — namely from direct spiritual sight — the very same things which we are here approaching more by the light of reason, taking our start from the facts of the external world.

We are led back then to a kind of interplay between the Earth and its celestial environment which gave men an inner life of ideation — mental pictures — and which was afterwards transmuted in such a way as to give rise to the life of sense-perception in its present form. (The life of the senses as such is of course a much wider concept; we are here referring to the form it takes in present time.)

But we must make a yet more subtle distinction. It is true that self-consciousness or Ego-consciousness, such as we have it in our ordinary life today, is only kindled in us in the moment of awakening. Self-consciousness trikes in upon us the moment we awaken. It is our relation to the outer world — that relation to it, into which we enter by the use of our senses — to which we owe our self-consciousness. But if we really analyze what it is that thus strikes in upon us, we shall perceive the following. If our inner life in mental pictures retained its dream-like quality and only the life of the senses were added to it, something would still be lacking. Our concepts would remain like the concepts of fantasy or fancy (I do not say identical with these, but like them). We should not get the sharply outlined concepts which we need for outer life. Simultaneously therefore with the life of the senses, something flows into us from the outer world which gives sharp outlines and contours to the mental pictures of our every-day cognitional life. This too is given to us by the outer world. Were it not for this, the mere interplay of sensory effects with the forming of ideas and mental pictures would bring about in us a life of fantasy or fancy and nothing more; we should never achieve the sharp precision of every-day waking life.

Now let us look at the different phenomena quite simply in Goethe's way, or — as has since been said, rather more abstractly — in Kizchhoff's way. Before doing so I must however make another incidental remark, Scientists nowadays speak of a “physiology of the senses”, and even try to build on this foundation a “psychology of the senses”, of which there are different schools. But if you see things as they are, you will find little reality under these headings. In effect, our senses are so radically different from one-another that a “Physiology of the senses”, claiming to treat them all together, can at more be highly abstract. All that emerges, in the last resort, is a rather scanty and even then very

questionable physiology and psychology of the sense of touch, which is transferred by analogy to the other senses. If you look for what is real, you will require a distinct physiology and a distinct psychology for every one of the senses.

Provided we remember this, we may proceed. With all the necessary qualifications, we can then say the following. Look at the human eye. (I cannot now repeat the elementary details which you can find in any scientific text-book.) Look at the human eye, one of the organs giving us impressions of the outer world, — sense-impressions and also what gives them form and contour. These impressions, received through the eye, are — once again — connected with all the mental pictures which we then make of them in our inner life.

Let us now make the clear distinction, so as to perceive what underlies the sharp outline and configuration which makes our mental images more than mere pictures of fancy, giving them clear and precise outline. We will distinguish this from the whole realm of imagery where this clarity and sharpness is not to be found, — where in effect we should be living in fantasies. Even through what we experience with the help of our sense-organs — and what our inner faculty of ideation makes of it — we should still be floating in a realm of fancies. It is through the outer world that all this imagery receives clear outline, finished contours. It is through something from the outer world, which in a certain way comes into a definite relation to our eye.

And now look around. Transfer, what we have thus recognized as regards the human eye, to the human being as a whole. Look for it, simply and empirically, in the human being as a whole. Where do we find — though in a metamorphosed form — what makes a similar impression? We find it in the process of fertilization. The relation of the human being as a whole — the female human body — to the environment is, in a metamorphosed form, the same as the relation of the eye to the environment. To one who is ready to enter into these things it will be fully clear. Only translated, one might say, into the material domain, the female life is the life of fantasy or fancy of the Universe, whereas the male is that which forms the contours and sharp outlines. It is the male which transforms the undetermined life of fancy into a life of determined form and outline. Seen in the way we have described in today's lecture, the process of sight is none other than a direct metamorphosis of that of fertilization; and vice-versa.

We cannot reach workable ideas about the Universe without entering into such things as these. I am only sorry that I can do no more than indicate them, but after all, these lectures are meant as a stimulus to further work. This I conceive to be the purpose of such lectures; as an outcome, every one of you should be able to go on working in one or other of the directions indicated. I only want to show the directions; they can be followed up in diverse ways. There are indeed countless possibilities in our time, to carry scientific methods of research into new directions. Only we need to lay more stress on the qualitative aspects, even in those domains where one has grown accustomed to a mere quantitative treatment.

What do we do, in quantitative treatment? Mathematics is the obvious example; ‘Phoronomy’ (Kinematics) is another. We ourselves first develop such a science, and we then look to find its truths in the external, empirical reality. But in approaching the empirical reality in its completeness we need more than this. We need a richer content to approach it with, than merely mathematical and phoronomical ideas. Approach the world with the premises of Phoronomy and Mathematics, and we shall naturally find starry worlds, or developmental mechanisms as the case may be, phoronomically and mathematically ordered. We shall find other contents in the world if once we take our start from other realms than the mathematical and phoronomical. Even in experimental research we shall do so.

The clear differentiation between the life of the senses and the organic life of the human being as a whole had not yet taken place in the time preceding the last Ice-Age. The human being still enjoyed a more synthetic, more ‘single’ organic life. Since the last Ice-Age man's organic life has undergone, as one might say, a very real ‘analysis’. This too is an indication that the relation of the Earth to the Sun was different before the last Ice-Age from what it afterwards became. This is the kind of premise from

which we have to take our start, so as to reach genuine pictures and ideas about the Universe in its relation to the Earth and man.

Moreover our attention is here drawn to another question, my dear Friends. To what extent is 'Euclidean space' — the name, of course, does not matter — I mean the space which is characterized by three rigid directions at right angles to each other. This, surely, is a rough and ready definition of Euclidean space. I might also call it 'Kantian space', for Kant's arguments are based on this assumption. Now as regards this Euclidean — or, if you will, Kantian — space we have to put the question: Does it correspond to a reality, or is it only a thought-picture, an abstraction? After all, it might well be that there is really no such thing as this rigid space. Now you will have to admit; when we do analytical geometry we start with the assumption that the X-, Y- and Z-axes may be taken in this immobile way. We assume that this inner rigidity of the X, Y and Z has something to do with the real world. What if there were nothing after all, in the realms of reality, to justify our setting up the three coordinate axes of analytical geometry in this rigid way? Then too the whole of our Euclidean Mathematics would be at most a kind of approximation to the reality — an approximation which we ourselves develop in our inner life, — convenient framework with which to approach it in the first place. It would not hold out any promise, when applied to the real world, to give us real information.

The question now is, are there any indications pointing in this direction, — suggesting, in effect, that this rigidity of space can not, after all, be maintained? I know, what I am here approaching will cause great difficulty to many people of today, for the simple reason that they do not keep step with reality in their thinking. They think you can rely upon an endless chain of concepts, deducing one thing logically from another, drawing logical and mathematical conclusions without limit. In contrast to this tendency in science nowadays, we have to learn to think with the reality, — not to permit ourselves merely to entertain a thought-picture without at least looking to see whether or not it is in accord with reality. So in this instance, we should investigate. Perhaps after all, by looking into the world of concrete things, there is some way of reaching a more qualitative determination of space.

I am aware, my dear Friends, that the ideas I shall now set forth will meet with great resistance. Yet it is necessary to draw attention to such things. The theory of evolution has entered ever more into the different fields of science. They even began applying it to Astronomy. (This phase, perhaps, is over now, but it was so a little while ago.) They began to speak of a kind of natural selection. Then as the radical Darwinians would do for living organisms, so they began to attribute the genesis of heavenly bodies to a kind of natural selection, as though the eventual form of our solar system had arisen by selection from among all the bodies that had first been ejected. Even this theory was once put forward. There is this p to the whole Universe the leading ideas that have once been gaining some particular domain of science.

So too it came about that man was simply placed at the latter end of the evolutionary series of the animal kingdom. Human morphology, physiology etc. were thus interpreted. But the question is whether this kind of investigation can do justice to man's organization in its totality. For, to begin with, it omits what is most striking and essential even from a purely empirical point of view. One saw the evolutionists of Haechel's school simply counting how many bones, muscles and so on man and the higher animals respectively possess. Counting in that way, one can hardly do otherwise than put man at the end of the animal kingdom. Yet it is quite another matter when you envisage what is evident for all eyes to see, namely that the spine of man is vertical while that of the animal is mainly horizontal. Approximate though this may be, it is definite and evident. The deviations in certain animals — looked into empirically — will prove to be of definite significance in each single case. Where the direction of the spine is turned towards the vertical, corresponding changes are called forth in the animal as a whole. But the essential thing is to observe this very characteristic difference between man and animal. The human spine follows the vertical direction of the radius of the Earth, whereas the animal spine is parallel to the Earth's surface. Here you have purely spatial phenomena with a quite evident inner differentiation, inasmuch as they apply to the whole figure and formation of the animal and man. Taking our start from the realities of the world, we cannot treat the horizontal in the same way as the vertical. Enter into the reality of space — see what is happening in space, such as

it really is, — you cannot possibly regard the horizontal as though it were equivalent or interchangeable with the vertical dimension.

Now there is a further consequence of this. Look at the animal form and at the form of man. We will take our start from the animal, and please fill in for yourselves on some convenient occasion what I shall now be indicating. I mean, observe and contemplate for yourselves the skeleton of an mammal. The usual reflections in this realm are not nearly concrete enough; they do not enter thoroughly enough into the details.

Consider then the skeleton of an animal. I will go no farther than the skeleton, but what I say of this is true in an even higher degree of the other parts and systems in the human and animal body. Look at the obvious differentiation, comparing the skull with the opposite end of the animal. If you do this with morphological insight, you will perceive characteristic harmonies or agreements, and also characteristic diversities. Here is a line of research which should be followed in far greater detail. Here is something to be seen and recognized, which will lead far more deeply into realty than scientists today are wont to go.

It lies in the very nature of these lectures that I can only hint at such things, leaving out many an intervening link. I must appeal to your own intuition, trusting you to think it out and fill in what is missing between one lecture and the next. You will then see how all these things are connected. If I did otherwise in these few lectures, we should not reach the desired end.

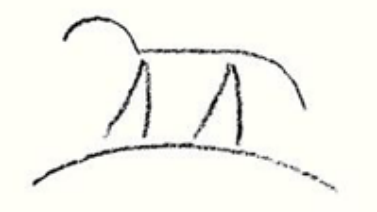

Fig. 2

Diagrammatically now (Fig. 2), let this be the animal form. If after going into an untold number of intervening links in the investigation, you put the question: ‘What is the characteristic difference of the front and the back, the head and the tail end due to?’, you will reach a very interesting conclusion. Namely you will connect the differentiation of the front end with the influences of the Sun. Here is the Earth (Fig. 3). You have an animal on the side of the Earth exposed to the Sun. Now take the side of the Earth that is turned away from the Sun. In one way or another it will come about that the animal is on this other side. Here too the Sun's rays will be influencing the animal, but the earth is now between. In the one case the rays of the Sun are working on the animal directly; in the other case indirectly, inasmuch as the Earth is between and the Sun's rays first have to pass through the Earth (Fig. 3).

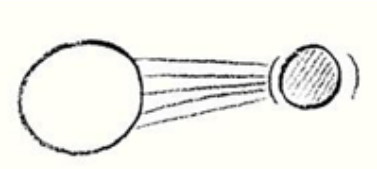

Fig. 3

Expose the animal form to the direct influence of the Sun and you get the head. Expose the animal to those rays of the Sun which have first gone through the Earth and you get the opposite pole to the head. Study the skull, so as to recognize in it the direct outcome of the influences of the Sun. Study the forms, the whole morphology of the opposite pole, so as to recognize the working of the Sun's rays before which the Earth is interposed — the indirect rays of the Sun. Thus the morphology of the animal itself draws our attention to a certain interrelation between Earth and Sun. For a true knowledge of the mutual relations of Earth and Sun we must create the requisite conditions, not by the

mere visual appearance (even though the eye be armed with telescopes), but by perceiving also how the animal is formed — how the whole animal form comes into being.

Now think again of how the human spine is displaced through right angle in relation to the animal. All the effects which we have been describing will undergo further modification where man is concerned. The influences of the Sun will therefore be different in man than in the animal. The way it works in man will be like a resultant (Fig. 4). That is to say, if we symbolize the horizontal line — whether it represent the direct or the indirect influence of the Sun — by this length, we shall have to say; here is a vertical line; this also will be acting. And we shall only get what really works in man by forming the resultant of the two.

Fig. 4

Suppose in other words that we are led to relate animal formation quite fundamentally to some form of cosmic movement — say, a rotation of the Sun about the Earth, or a rotation of the Earth about its own axis. If then this movement underlies animal formation, we shall be led inevitably to attribute to the Earth or to the Sun yet another movement, related to the forming of man himself, — a movement which, for its ultimate effect, unites to a resultant with the first. From what emerges in man and in the animal we must derive the basis for a true recognition of the mutual movements among the heavenly bodies.

The study of Astronomy will thus be lifted right out of its present limited domain, where one merely takes the outward visual appearance, even if calling in the aid of telescopes, mathematical calculations and mechanics. It will be lifted into what finds expression in this most sensitive of instruments, the living body. The forming forces working in the animal, and then again in man, are a clear indication of the real movements in celestial space.

This is indeed a kind of qualitative Mathematics. How, then, shall we metamorphose the idea when we pass on from the animal to the plant? We can no longer make use of either of the two directions we have hitherto been using. Admittedly, it might appear as though the vertical direction of the plant coincided with that of the human spine. From the aspect of Euclidean space it does, no doubt (Euclidean space, that is to say, not with respect to detailed configuration but simply with respect to its rigidity.) But it will not be the same in an inherently mobile space. I mean a space, the dimensions of which are so inherently mobile that in the relevant equations, for example, we cannot merely equate the x- and the y-dimensions: $y = f(x)$. (The equation might be written very differently from this. You will see what I intend more from the words I use than from the symbols; it is by no means easy to express in mathematical form.) In a co-ordinate system answering to what I now intend, it would no longer be permissible to measure the ordinates with the same inherent measures as the abscissae. We could not keep the measures rigid when passing from the one to the other. We should be led in this way from the rigid co-ordinate system of Euclidean space to a co-ordinate system that is inherently mobile.

And if we now once more ask the question: How are the vertical directions of plant growth and of human growth respectively related? — we shall be led to differentiate one vertical from another. The question is, then, how to find the way to a different idea of space from the rigid one of Euclid. For it may well be that the celestial phenomena can only be understood in terms of quite another kind of space — neither Euclidean, nor any abstractly conceived space of modern Mathematics, but a form of space derived from the reality itself. if this is so, then there is no alternative; it is in such a space and not in the rigid space of Euclid that we shall have to understand them.

Thus we are led into quite other realms, namely to the Ice-Age on the one hand and on the other to a much needed reform of the Euclidean idea of space. But this reform will be in a different spirit than in the work of Minkowski and others. Simply in contemplating the given facts and trying to build up a science free of hypotheses, we are confronted with the need for a thoroughgoing revision of the concept of space itself. Of these things we shall speak again tomorrow.

Lecture VIII
Stuttgart, January 8, 1921

My Dear Friends,

To lead our present studies to a fruitful conclusion we must still pursue the rather subtle course I have been adopting, bringing together a great variety of ideas from different fields. For this reason we shall have to continue with this course also while the other course [1] is going on — between the 11th and 15th January. We must arrange the times by agreement with the Waldorf School. There is so much to bring in that we shall need these days too. Now I am also well aware how many queries, doubts and problems may be arising in connection with this subject. Please prepare whatever questions you would like to put, if you need further elucidation. I will then try to incorporate the answers in one of next week's lectures, so as to make the picture more complete. Working in this way we shall be able to continue as heretofore, bringing in what I would call the subtler aspects of our theme.

Let us envisage once again the course we have been pursuing. Our aim is to gain a deeper understanding of Astronomy — the science of the Heavens — in connection with phenomena on Earth. To begin with, we pointed out that as a rule the Astronomy of our time only takes into account what is observed directly with the outer senses aided, no doubt, by optical instruments and the like. Such, in the main, were all the data hitherto adduced when seeking to explain and understand the phenomena of the Heavens. They took their start from the 'apparent movements', as they would now be called, or the celestial bodies. First they considered the apparent movement of the starry Heavens as a whole around the Earth and the apparent movement of the Sun. Then they observed the very strange paths described by the Planets. Such, in effect, is the immediate visual appearance; portions of the planetary paths look like loops (Fig. 1) the planet moves along here, reverses and goes back, and then forward again, here ... And now they reasoned; if the Earth itself is moving and we have no direct perception of this movement, the real movements of the heavenly bodies cannot but be different from the visual appearance. Interpreting along these lines — applying mathematical and geometrical laws — they arrived at an idea of what the 'real' movements might be like. So they arrived at the Copernican system and at its subsequent modifications. Such, in the main, were the methods of cognition used; first, what our senses when looking out into the Heavens, and then the intellectual assimilation, the reasoned interpretation of these sense-impression.

Fig. 1

We then pointed out that this procedure can never lead to the adequate penetration of the celestial phenomena, if only for the reason that the mathematical method itself is insufficient. We begin our calculations along certain lines and are then brought to a stop. For as I was reminding you, the ratios between the periods of revolution of the several planets are incommensurable numbers, — incommensurable magnitudes. By calculation therefore, we do not reach the innermost structure of the celestial phenomena. Sooner or later we have to leave off.

It follows that we must adopt a different method. We have to take our start not only from what man observes when he looks out into the Universe with his senses; we must take man as a whole in his connection with the Universe, and perhaps not only man, but other creatures too, — the kingdoms of Nature upon Earth. All these things we pointed out, and I then showed how the whole organization of man can be seen in relation to certain phenomena in the evolution of the Earth, namely the Ice-Ages in their rhythmical recurrence. They also have to do with the inner evolution of man and of mankind.

This too, I said, will give us indications of what the real movements in celestial space may be. These are the kind of things we must pursue.

Before continuing the rather more formal lines of thought with which we ended yesterday's lecture, let us consider once again this connection of man's evolution with the evolution of the Earth through the Ice-Ages. We saw that the special kind of knowledge or of cognitional life which the man of present time calls his own has only come into being since the last Ice-Age. Moreover all the civilization-epochs, of which I have so often told, have taken place since then — namely the Ancient Indian, the Persian, the Egypto — Chaldean, the Graeco-Latin and then the epoch in which we are now living. Before the last Ice-Age, we said, there must have been developing in human nature what in the man of today is more withdrawn, less at the surface of his nature, namely his power of ideation — the forming of mental pictures. The inner quality, we said, of this part of our inner life is truly to be understood only if we compare it with our dream-life. It is through sense-perception that our mental pictures receive clear and firm configuration and, as it were, a fully saturated content. The mental pictures are being formed in a more inward region of our bodily organic life — farther back, as it were behind the sense-perceptions, — and this activity is dim and hazy like our dream-life. Our forming of mental pictures would be as dim as it is in dreams, if the experiences of the senses did not strike in upon us every time we awaken. (We may allow the supposition, to help explain what is meant.)

More dim and hazy than our life in sense-perception, this inner life of ideation, mental imagery, is related to those earlier phases in the evolution of man's nature which preceded the last glacial epoch, or which — to speak in anthroposophical terms — belonged to old Atlantis.

What must it then have been like for man? In the first place he must have had a far more intimate inner connection with the surrounding world than he has today through sense-perception. We can control our sense-perception with our will. It is with our will at any rate that we direct the vision of our eyes, and by deliberate attention we can go even farther in governing our sense-perception by our own will. At all events, our will is very much at work in our sense — perceptions, making us to a large extent independent of the outer world. We orientate ourselves by our own arbitrary choice. Now this in only possible because as human beings we have in a way emancipated ourselves from the Universe. Before the last Ice-Age we cannot have been thus emancipated. (I say ‘cannot have been’ since I am wanting now to speak from the empirical aspect of external Science.) During that time, as we have seen, the power of ideation — the forming of mental images — was especially developed, and in his inner conditions man must have been far more dependent on all that was going on around him. Today we see the world around us shining in the sunlight, but the way we see it is considerably subject to the inner culture and control of our own life of will. In Atlantean time the way man was given up to the outer world must have been somehow dependent on the illumined Earth and its illumined objects, and then again — at night-time when the Sun was not shining — on the darkness, the gloaming. He must in other words have experienced periodic alternations in this respect. His inner life of mental imagery, which as we saw was then in process of development must alternately have been lighting up and ebbing down again. This inner periodicity, brought about by man's relation to the surrounding Universe, was indeed not unlike the peculiar periodicity of woman's organic functions of which we spoke before, which is related to the Lunar phases though only as regards length of time. This inner functioning of the woman's nature (I said, you will remember, it is there in man too but in a more inward way and therefore less easily perceived) was at one time actually linked with the corresponding events in the outer Universe. It then became emancipated — a property of human nature on its own, — so that what now goes on in the human being in this respect need not coincide with the outer events. yet the periodicity — the sequence of phases — remains the same as it was when the one coincided with the other.

Something quite similar is true of the rhythmic alternation in our inner life — in our ideation, our forming of mental images. The whole way we are organized in this respect, implanted in us in a far distant past, is to this day more or less independent of the life of the outer senses. Day by day we undergo an inner rhythm, our powers of mental imagery alternately lighting up and growing more dim; it is a daily ebb and flow. We only fail to notice it, since it is far less intense than that other periodicity

which runs parallel to the Lunar phases. Nevertheless, in our head-organization to this day we have an alternation between a brighter and a dimmer kind of life. We carry in our head a rhythmic life. We are at one time more and at another less inclined to meet our sense-perceptions actively from within. It is a 24-hour rhythmic alteration. It would be interesting to observe — it might even be recorded in graphically — how human being vary as regards this inner period of the head, the forces of ideation and mental imagery alternating between brighter and more lively and then again dimmer and more sleepy times. The dim and sleepy times represent, so to speak, the inner night of the head, the brighter ones the inner day, but it does not coincide with the external alternation of day and night. It is an inner alternation of light and darkness, or relatively bright and dim conditions. And people vary in this respect. One human being has this inner alternation of light and dark in such a way that he tends rather to connect the lighter period of his mental image-forming power with his sense-perceptions. Another tends to it with the darker. Individuals are organized in one way or the other, and differ accordingly as to their power of observing the outer world. One human being will be inclined sharply to focus the phenomena of the outer world; another tends to do so less, — is more inclined to an inner brooding. All this is due to the alternating conditions I have been describing. Notably as educators, my dear Friends, we should cultivate the habit of observing things like this. They will be valuable signposts, indicating how we should treat the individual children both in our teaching and in education generally.

What interests us however here and now is the fact that man thus makes inward, as it were, what he once underwent in direct mutual relation with the outer world; so that it now works in him as an inner rhythm, the phases no longer coinciding with the outer yet still retaining the periodicity Before the Ice-Age, man's periods of brighter and more intimate participation in the surrounding Universe,. and then of dim withdrawal into himself, will have coincided regularly with the processes of the outer world. He still retains an echo of this rhythm, which in those long-ago times proceed from his living-together with the Universe around him, where at one moment his consciousness was lightened and filled with pictures while at another he withdrew into himself, brooding over the pictures. It is an echo of this latter state whenever we today are inclined to brood more or less melancholically in our own inner life. Once again therefore, what man experienced in and with the world in those older times has been driven farther back into his inner bodily nature, while at the outer periphery a new development has taken place in his faculties of sense-perception. He had these faculties, of course in earlier epochs too, but not developed in the way they now are.

While looking thus at what has taken place in man through his connection with the phenomena of the world around him, we are in fact looking into the Universe itself. Man then becomes the reagent for a true judgment of the phenomena of the Universe. But to complete this we need the other kingdoms of Nature too. Here I should like to draw your attention to something well-known and evident to everyone, the essential significance of which, however, remains unrecognized.

Consider the annual plant, — the characteristic cycle of its development. We see in it quite evidently what I was mentioning yesterday — the direct and indirect influences of the Sun. Where the Sun works directly, the flower comes into being; where the Sun works in such a way that the Earth comes in between, we get the root. The plant too makes manifest what we were speaking of yesterday as regards the animal and then applied in another way to man.

Yet we shall only see the full significance of this if we relate it to another fact. There are perennial plants too. What is the relation of the perennial plant to the annual, as regards the way in which plant-growth belongs to the Earth as a whole? The perennial retains its stem or trunk, and the truth is: Year by year a new world of plants springs, so to speak, from the trunk itself. Of course it is modified and metamorphosed, yet it is a vegetation growing on the trunk, which in its turn grows out of the Earth (Fig. 2). If you have morphological perception you will see it as clearly as can be, — it almost goes without saying. Here on the left I have the surface of the Earth, 0 the annual plant springing from it. Here on the right is the stem or trunk of the perennial, from which new vegetation, new plant-growth springs in each succeeding year. I must image something or other (to leave it vague, for the moment) continued from the Earth into the trunk. I must say to myself — what this plant here (Fig. 2 on the left) is growing on, must somehow be there in the trunk too (on the right). In other words there must be

some element of the Earth — whatever it may be — entering into the trunk. I have no right to regard the trunk of the perennial as a thing apart, not belonging to the Earth; rather must I regard it as a modified portion of the Earth itself. Only then shall I be seeing it rightly; only then shall I discern the inner relationships, such as they really are. Something is there in the perennial plant, which otherwise is only in the Earth. It is through this that the plant becomes perennial. In effect, precisely by taking something of the Earth into itself it frees itself from dependence on the yearly course of the Sun. For we may truly say: The perennial wrests itself away from its dependence on the Sun's yearly course. it emancipates itself from the yearly course of the Sun, in that it forms the trunk, receiving into its own Nature — becoming able, as it were, to do for itself what otherwise could only come about through the working of the whole cosmic environment.

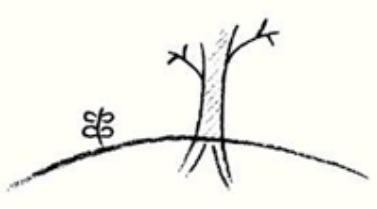

Figure 2

Do we not here see prefigured in the plant world, what I was just describing with regard to man in preglacial times? For in those times, as I was showing, the inner rhythm of the man's ideation — his life in mental pictures — developed by relation to the surrounding world. What then lived in the mutual relation between man and the surrounding world has since become a feature of his own inner life. There is an indication of the same kind of change in the plant kingdom, in that the annual is changed to a perennial. This is indeed a universal tendency in evolution; the living entities are on the way to emancipation from their original connections with the surrounding world.

Seeing the perennials arising, we have to say: It is as though the plant, when it becomes perennial, had learned something it you will allow the expression — learned from the time when it depended on cosmic environment, something which it can now do for itself. Now it is able of itself to bring forth fresh plant-shoots year by year. We do not reach an understanding of the phenomena of the world by merely staring at the things that happen to be side by side, or that are crowded into the field of view under the microscope. We have to see the larger whole and recognize the single phenomena in their connection with it.

Look at it all once more. The annual plant is given up to the cycle of the year, with all the changing relations to the Cosmos which this involves. This influence of the Cosmos beings to fade away in the perennial. In the perennial, what would otherwise vanish in the further course of the year is, as it were, preserved. In the trunk we see springing from the ground the working of the year, made permanent and lasting. This transition of what was first connected with the outer Universe into a more inward way of working we see it throughout the whole range of Nature's phenomena, in so far as they are cosmic. Hence too there are phenomena in which we can more quickly find the living connections between our Earth and the wider Cosmos, whilst there are others in which the cosmic influences are more concealed. We need to find out which of them are sensitive reagents, telling of the cosmic influences. The annual plant will tell us of the Earth's connection with Cosmos, the perennial will not be able to tell us much.

Again, the relation of the animal to man can give us an important clue. Look at the animal's development. (Though we might also include it, we will for the moment disregard the embryonic life.) The animal is born and grows up to a certain limit. It reaches puberty. Look at the animal's whole life, until puberty and beyond. Without any added hypotheses — taking the simple facts — you must admit that it is strange, what happens to the animal once puberty has been attained. For in a way the animal is finished then, so far as the earthly world is concerned. Any such statement is of course an approximation to the truth, needless to say; yet in the main we must admit that in the animal no further

progression is to be seen, not after puberty. Puberty is the important goal of animal development. The immediate consequence of puberty — all that happens as an outcome of it — is there of course, but we cannot allege that anything takes place thence forward, deserving to be called a true progression.

With man it is different. Man remains capable of development far beyond puberty; but the development becomes more inward. Indeed it would be very sad for man if in his human nature he were to end his development at puberty in the way animals do. Man goes beyond this. He holds something in reserve by means of which he can go farther, — can undertake quite other journeys, unconnected with sexual maturity or puberty. This again is not unlike the "inwarding" of the cycle of the year in the perennial as against the annual plant. What is in evidence in the animal when puberty is reached, we see it transmuted into a more inward process in man, from puberty onward. Something therefore is at work in man, that is related to a cosmic process in his development from birth until puberty, and that then gets emancipated from the Cosmos — just as it does in the perennial plant — when puberty has been outgrown.

Here then you have a subtler way of estimating the phenomena among the kingdoms of Nature; so will you presently find signposts, indicating the connections between the creatures upon Earth and the Cosmos. We see how, when the cosmic influences cease as such, they are transplanted into the inner nature of the several creatures. We will take note of this and set it on one side for the moment; later we shall find the synthesis between this and quite another aspect.

Let us now take up again what I have frequently mentioned: The incommensurable ratios between the periods of revolution of the planets of the solar system. We may ask, what would the outcome be if they were commensurable? Cumulative disturbances would arise, whereby the planetary system would be brought to a standstill. This can be proved by calculation, though it would lead too far afield to do it now. Only the incommensurability between the periods of revolution enables the planetary system, so to speak, to stay alive. In other words, the solar system contains among other things a condition even tending to a standstill. It is precisely this condition which we are calculating. When in our calculations we get to the end of our tether, there is the incommensurable — and there, withal, is the very life of the planetary system! We are in a strange predicament when calculating the planetary system. If it were such that we could fully calculate it, it would die, — nay, as I said before, would have died long ago. It lives by virtue of the face that we can not calculate it fully. What is alive in the planetary system is precisely what we cannot calculate.

Now upon what do we base these calculations, from which once more, if we could pursue them to the end, we must deduce the inevitable death of the whole system? We base them on the force of gravitation — universal gravitation. Suppose we take our start from gravitation and nothing more, and think it out consistently. We get the picture of a planetary system subject to the force of gravitation. Then indeed we do arrive at commensurable ratios. But the planetary system would inevitably die. We calculate, in other words, to the extent that death prevails in the planetary system, basing our calculations on the force of gravity. In other words there must be something in the planetary system — different from gravitation — to which the incommensurability is due.

The planetary orbits can be brought into accord with the force of gravity very nicely, even as to their genesis, but their periods of revolution would then have to be commensurable. Now there is something which cannot be brought into accord with the force of gravitation, and which moreover does not so tidily fit into our planetary system. I mean what reveals itself in the cometary bodies. The comets play a very strange part in the system, and they have recently been leading scientists to some unusual ideas.

I leave aside the kind of explanations which often tend to arise, where anything most recently discovered is seized on to explain phenomena in other fields. In physiology for instance there was a time when they were fond of comparing the so-called sensory nerves to telegraph-wires leading in from the periphery. Through some central switch or commutator the impulse was supposed to be transmitted, leading to impulses and acts of will. From the centripetal nerves it was supposed to be

switched over to the centrifugal; they compared it all to a telegraphic system. Maybe one day something quite different from telegraph-wires will be invented and by this way of thinking quite another picture will be applied to the same thing. So do the scientific fashions change. Whatever happens to have been discovered is quickly seized on as a handy way of explaining the phenomena in other fields. Much as they do in medicine! Scarcely has any new thing been found, — it is "discovered" to be a valuable remedy, though little thought is given to the inner reasons. Now that we have X-rays, X-rays are the remedy to use; we only use them because we happen to have found them. It is as though men let themselves be swept along chaotically, willy-nilly by whatever happens to turn up from time to time.

So for the comets: By spectroscopic investigation and by comparison with the corresponding results for the planets, the idea arose that the phenomena might be explained electromagnetically. Such ideas will at most lead to analogies, which may no doubt have some connection with the reality, but which will certainly not satisfy us if we are looking into it more deeply.

Yet as I said, leaving this aside, there was one thing which emerged quite inevitably when the phenomena of comets were studied in more detail. While for the rest of the planetary system they always speak of gravitational forces, the peculiar position of the comet's tail in relation to the Sun inevitably drove the scientists to speak of forces of repulsion from the Sun — forces, as it were of recoil. The terminology is not the main point; it will of course vary with the prevailing fashion. The point is that science was here obliged to look for something in addition to — and indeed opposite to gravity.

In effect, with the comets something different enters our planetary system, — something which in its nature is in a way opposite to the inner structure of the planetary system as such. Hence it is understandable that for long ages the riddle of the comets gave rise to manifold superstitions. Men had a feeling that in the courses of the planets laws of Nature, inherently belonging to our planetary system, find expression, while with the comments something contrary comes in. Here something disparate and diverse makes its way into our planetary system. Thus they inclined to see the planetary phenomena as an embodiment of normal laws of Nature, and to regard the cometary apparitions as something contrary to these normal laws. There were times — though not the most ancient times — when comets were associated, as it were, with moral forces flying through the Universe, scourges for sinful man.

Today we rightly look on that as superstition. Yet even Hegel could not quite escape associating the comments with something not quite explicable or only half explicable by ordinary means. The 19th century, of course, no longer believed the comets to appear like judges to chastise mankind. Yet in the early 19th century they had statistics purporting to connect them with good and bad vintage years. These too occur somewhat irregularly; their sequence does not seem to follow regular laws of Nature. And even Hegel did not quite escape this conclusion. He though it plausible that the appearance or non-appearance of comments should have to do with the good and bad vintage years.

The standpoint of the people of today — at least, of those who share the normal scientific outlook — is that our planetary system has nothing to fear from the comets. Yet the phenomena which they evoke within this planetary system somehow have little inner connection with it. Like cosmic vagrants they seem to come from very distant regions into the near neighborhood of our Sun. Here they call forth certain phenomena, indicating forces of repulsion from the Sun. The phenomena appear, was and wane, and vanish.

There was a man who still had a certain fund of wisdom where by he contemplated the Universe not only with his intellect but with the whole human being. He still had some intuitive perception of the phenomena of the Heavens. I refer to Kepler. He was the author of a strange saying about the comets — a saying which gives food for thought to anyone who is at all sensitive to Kepler; way of though and mood of soul. We spoke of his three Laws — a work of genius, when one considers the ideas and the data which were accessible in his time. Kepler arrived at his Laws out of a feeling for the inner

harmony of the planetary system. For him it was no mere dry calculation; it was a feeling of harmony. He felt has three planetary Laws as a last quantitative expression of something qualitative — the harmony pervading the whole planetary system. And out of this same feeling he made a statement about the comets, the deep significance of which one feels if one is able to enter into such things at all. Kepler said: In the great Universe — even the Universe into which we look by night — there are as many comets as there are fishes in the ocean. We only see very, very few among them, while all the rest remain invisible, either because they are too small or for some other reason. Even external research has tended to confirm Kepler's saying. The comets seen were recorded even in olden time and it is possible to compare the number. Since the invention of the telescope ever so many more have been seen than before. Also when looking out into the starry Heavens under different conditions of illumination — that is to say, making provision for extreme darkness — a larger number of comets are recorded than otherwise. Even empirical research therefore comes near to what Kepler exclaimed, inspired as he was by a deep feeling for Nature.

Now if one speaks at all of a connection between the Cosmos and what happens on the Earth, it surely is not right to dwell one — sidedly on the relation to our Earth of the other planets of our system and to omit the heavenly bodies which come and go as the comets do. It is especially one-sided since we must now admit that the comets give rise to phenomena indicating the presence of quite other forces — forces opposite in kind to those to which we usually attribute the coherence of our planetary system. The comets do in fact bring something opposite into our system, and if we follow it up we must admit that this too is of great significance. Something in some way opposite in nature to the force which holds it together, comes with the comets into our planetary system.

In an earlier lecture-course about natural phenomena I drew attention to something of which I must here remind you. Those who were present — the course was mainly about Heat or Warmth[2] — will no doubt recall it. I said that when we look at the phenomena of warmth in their relation to other phenomena of the Universe we are obliged to form a far more concrete idea of the Ether, of which the physicists generally speak in rather hypothetical terms. I said that in the formulae of Physics, wherever the force of pressure occurs as regards ponderable matter, we have to replace it by a force of suction as regards the ether. In other words, if we insert a plus sign for the intensity of a force in the realm of ponderable matter, we must give a minus sign to the corresponding intensity in the ether. I suggested that the well-known formulae should be looked through with this end in view; for one would see how remarkably, when this is done, they harmonize with the phenomena of Nature.

Take for example that whole game of thought, if I may call it so, the Kinetic Theory of Gases, of of Heat itself, — the molecules impinging on each other and on the walls of the containing vessel. Take all this brutal play of mutual impact and recoil which is supposed to represent the thermal condition of gas. Instead of this phenomena will become clear and penetrable the moment we perceive that within warmth itself there are two conditions. akin to the conditions that prevail in ponderable matter; the other must be thought of as akin to the ether. Warmth is in this respect different from Air or Light. For light, if we are calculating truly we must use the negative sign throughout. Whatever in our formulae is to represent the effects of light, must bear a negative sign. For air or gas the sign must be positive. For warmth on the other hand, the positive and negative will have to alternate. What we are wont to distinguish as conducted heat, radiant heat and so on will only then become clear and transparent.

Within the realm of matter itself, these things reveal the need for a qualitative transition from the positive to the negative in characterizing the different kinds of force. And we now see, very significantly, how for the planetary system we also have to pass from the positive — that is, gravitation — to the corresponding negative, the repelling force.

One more thing I will say today, if only to formulate the problem. For the moment I will carry it no further, but only put the problem; we shall have time to go into these things in later lectures. Now that we have ascertained all this about the cometary bodies, let me compare the relation between our planetary system and the comets to what is there in the ovum, the female germ-cell, in its relation to the male element, the fertilizing sperm. Try to imagine, try to visualize the two processes, as you

might actually see them. There is the planetary system; it receives something new into itself, namely the effects of a comet. There is the ovum; it receives into itself the fertilizing effect of the male cell, the spermatozoid.

Look at the two phenomena side by side without prejudice, as you might do in ordinary life when you see two things obviously comparable, side by side. Do you not find plenty of comparable features when you contemplate these two? I do not mean to set up any theory or hypothesis, I only want to indicate what you will see for yourselves if you once look at these things in their true connection.

Taking our start from this, tomorrow we may hope to enter into more concrete and more detailed aspects.

Notes:

1. Examples of the relation of Spiritual Science to the different branches of Science. Four lectures to students, Stuttgart, 11th to 15th January, 1921. Published (in the original German) in the Swiss periodical “Gegenwart”, Vol. 14, nos. 2 to 8, Berne, 1952.

2. Stuttgart, 1st to 14th March 1920, generally known as the “Second Scientific Lecture-Course”. Issued (in the original German) by the Science Section of the Goetheanum, Dornach, Switzerland, 1925.

Lecture IX
Stuttgart, January 2, 1921

My Dear Friends,

We have now reached a point in our studies from which we must proceed with extreme caution, in order to see where there is a danger of allowing our thought to depart from reality and to see also when we are avoiding this danger, by keeping within the bounds of what is real.

Last time, we suggested the comparison of two facts: The appearance within the planetary system of the cometary phenomena, and, alas within the planetary system, though perhaps not bearing quite the same relationship to it, all that we observe in the phenomena of fertilization. In order, however, to come to ideas about this which are at all justified, we must first see whether it is indeed possible to find connections between two so widely separated things, with which we are confronted in the external world of facts. In scientific method, we shall not make real progress, unless we can refer from one realm of facts to another, manifesting something of a similar nature and thus leading us on.

We have seen how on the one hand we have to use the element of figure and form, the mathematical, and then how we are again and again impelled to come to terms in one way or another with the qualitative aspect, in some way to find a qualitative approach. And so today we will bring in something which arises in regard to man if one really studies this man, who is, after all, in some way an image of the heavenly phenomena, — as the many statements in these lectures may enable us to deduce. Yet we still have to establish in what way he is this image. If this is what he is, we must first of all gain a clear understanding of man himself. We must understand the picture from which we intend to take our start, — understand its inner perspective. Just as in looking at a painting one must know what a foreshortening means, and so on, in order to pass from the picture to the real spatial relationships and to relate the picture to what it represents in reality, so, if we would approach reality in the universe, interpreting it through man, we must first be clear about man. Now it is, extraordinarily difficult, as a human being, to come near to the human being with palpable ideas. Therefore, I should like today to bring before your souls what I might call “palpably impalpable” thought-pictures arising from quite simple foundations, ideas with which most of you are probably already well acquainted, but which we must nevertheless bring before our minds in a certain connection. These ideas, which seem in part to be quite easy to grasp and yet again, beyond certain limits, to elude our comprehension, will afford us a means of orientation in the striving to take hold of the outer world through ideas.

It may appear somewhat forced to keep emphasizing the necessity of referring back to man's life of pictorial imagination in order to understand the phenomena of the heavens. But after all it is obvious that however carefully we may describe the heavenly phenomena, we have, to begin with, nothing more than a form of optical picture, permeated with mathematical thoughts. What Astronomy gives us has fundamentally the character of a picture. To be on the right path, we must therefore concern ourselves with the arising of the picture in man, otherwise we shall gain no true relationship to what Astronomy can say to us. And so I should like today to proceed from some quite simple mathematics and to show you how, in a different domain from that to which we were led through the ratios of the periods of revolution of the planets, there appears within Mathematics itself this element of the incomprehensible, the impalpable. We meet with it when in a certain connection we study quite familiar curves. (As I said, many of you already know what I am about to describe, I only want to elucidate the subject today from a particular aspect.)

Consider the Ellipse, with its two foci A and B, and you know that it is a definition of the ellipse that for any point M of the curve, the sum of its distances (a + b) from the two foci remains constant. It is characteristic of the ellipse, that the sum of the distances of any one of its points from two fixed points, the two foci, remains constant (Fig. 1).

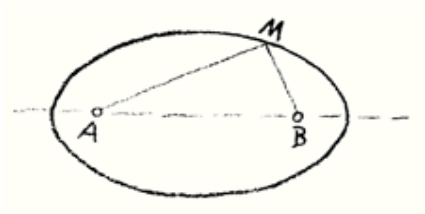

Fig. 1

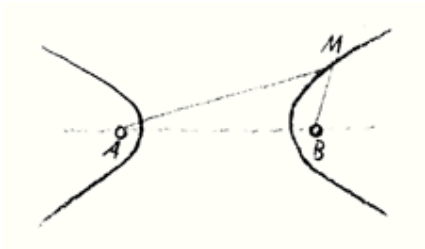

Fig. 2

Then we have a second curve, the Hyperbola (Fig. 2). You know that it has two branches. It is defined in that the difference of the distances of any point of the curve from the two foci, (b - a) is a constant magnitude. In the ellipse, then, we have the curve of the constant sum, in the hyperbola, the curve of constant difference, and we must now ask: What is the curve of constant product?

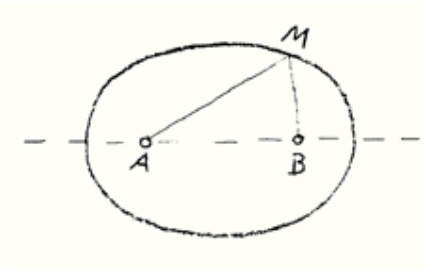

Fig. 3

I have often drawn attention to this: The curve of constant product is the so-called Curve of Cassini (Fig. 3). We find it when, having two points, A and B, we consider a point M in regard to its distances from A and B, and establish the condition that the two distances AM and BM multiplied together should equal a constant magnitude. For the sake of simplicity in the calculation, I will call the constant magnitude b2 and the distance AB, 2a. If we take the mid-point between a and b as the center of the axes of a co-ordinate system and calculate the ordinates for each point that fulfills these conditions, — take C as the center of the co-ordinate system and let the point whose ordinate we will call y move round so that for each point of the curve AM x BM = b2 , we get the following equation. (I will only give you the result, for the simply reason that everyone can easily work out the calculation for himself; it is to be found in any mathematical text-book relating to the subject.) We find for y the value:

$$y = \pm \sqrt{-(a^2 + x^2) \pm \sqrt{b^4 + 4a^2 x^2}}$$

Taking here into account that we cannot use the negative sign because we should then have an imaginary y, and considering therefore taking only the positive sign, we have:

$$y = \pm \sqrt{-(a^2 + x^2) + \sqrt{b^4 + 4a^2 x^2}}$$

If we then draw the corresponding curve, we have a curve, rather like but not identical with an ellipse, called the curve of Cassini (Fig. 4). It is symmetrical to the left and right of the ordinate axis and about and below the abscissa axis.

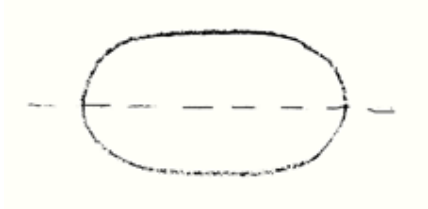

Fig. 4

But now, this curve has various forms, and for us at any rate this is the important thing about it. The curve has different forms, according to whether b, as I have taken it here, is greater than a, equal to a, or less than a. The curve I have just drawn arises when $b > a$, and furthermore when another condition is fulfilled, namely, that b is also greater than or equal to $a\sqrt{2}$. Moreover, when $b > a\sqrt{2}$, there is a distinct curvature above and below, If $b = a\sqrt{2}$, then at this point above and below, the line of the curve becomes straightened,m it flattens so much that it almost becomes a straight line (Fig. 4). If, however, $b < a\sqrt{2}$, then the whole course of the curve is changed and it takes on this form (Fig. 5). And if $b = a$, the curve passes over into a quite special form, it changes into this form (Fig. 6). It runs back into itself, cuts through itself and comes out on the other side, and we obtain the special form of the Lemniscate. The lemniscate, then, is a special form of Curve of Cassini — these curves are so named after their discoverer. The particular form assumed by the curve is determined by the ratio between the constant magnitudes which appear in the equation characterizing the curve. In the equation, we have only these two constant magnitudes, b and a, and the form of the curve depends on the ratio between them.

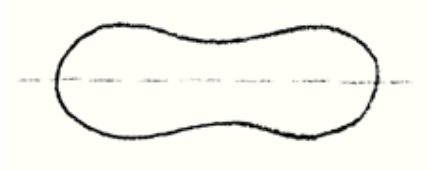

Fig. 5

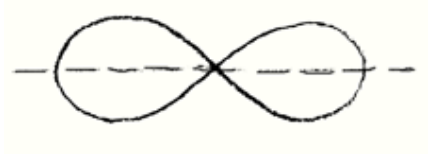

Fig. 6

Then the third case is possible, that $b < a$. If $b < a$, we can still find values for the curve. We can always solve the equation and obtain values for the curve, ordinates and abscissae, even when b is smaller than a, only the curve then undergoes yet another metamorphosis. For when $b < a$, we find two branches of the curve, which look something like this (Fig. 7). We have a discontinuous curve. And here we come to the point where the mathematics itself confronts us with what I called the “palpably impalpable”, something that is difficult to grasp in space. For in the sense of the mathematical equation, this is not two curves, but one; it is a single curve in exactly the same way as all these are single curves (Figs. 3 through 5). In this one (the lemniscate) there is already a transition. The point which describes the curve takes this path, goes round underneath, cuts its previous path here and continues on here (Fig. 7). Here, we must picture the following: If we let the point M move along this line, it does not simply cross over from one side to the other, — it does not do this. It runs along the path just as in the other curves, describes a curve here, but then manages to turn up again here (Fig. 7)

You see, that which carries the point along the line disappears here in the middle. If you want to understand the curve you can only imagine that it disappears in the middle. If you try to form a continuous mental picture of this curve, what must you do?

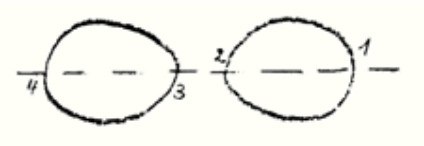

Fig. 7

It is quite easy, is it not, to imagine curves such as thes. (I only say this in parenthesis for the ordinary philistine!) You can go on imagining points along the curve and you do not find that the picture breaks off. Here (in the lemniscate) admittedly, you have to modify the comfortable way of simply going round and round, but still it goes on continuously. You can keep hold of the mental picture. But now, when you come to this curve (Fig. 7), which is not so commonplace, and you want to image it, then, in order to keep the continuity of the idea you will have to say: Space no longer gives me a point of support. In crossing over to the other branch in my imagination, unless I break the continuity and regard the one branch as independent of the other, I must go out of space; I cannot remain in space. So you see, Mathematics itself provides us with facts which oblige us to go out of space, if we would preserve the continuity of the idea. The reality itself demands of us that in our ideas we go out of space. Even in Mathematics therefore we are confronted with something which shows us that in some way we must leave space behind, if the pure idea is to follow its right path. Having ourselves and going the idea is beginning to think the process through, we must go on thinking in such a way that space is no longer of any help to us. If this were not so, we should not be able to calculate all possibilities in the equation.

In pursuing similar line of thought, we meet with other instances of this kind. I will only draw your attention to the next step, which ensures if one things as follows. The ellipse is the locus of the constant sum, — it is defined by the fact that is is the curve of constant sum. The hyperbola is the curve of constant difference. The curve of Cassini in its various forms is the curve of constant product. There must then be a curve of constant quotient also, if we have here A, here B, here a point M, and then a constant quotient to be formed through the division of BM by AM. We must be able to find different points, M 1, M 2, etc., for which

$$\frac{BM_1}{AM_1} = \frac{BM_2}{AM_2}$$

etc. are equal to one another and always equal to a constant number. This curve is, in fact, the Circle. If we look for the points M1, M2 etc. we find a circle which has this particular relationship to thee points A and B (Fig. 8). So that we can say: Besides the usual, simple definition of a circle, — namely, that it is the locus of a point whose distance from a fixed point remains constant, — there is another definition. The circle is that curve, very point of which fulfills the condition that its distances from two fixed points maintain a constant quotient.

Now, in considering the circle in this way there is something else to be observed. For you see, if we express this

$$\frac{BM}{AM} = \frac{m}{n},$$

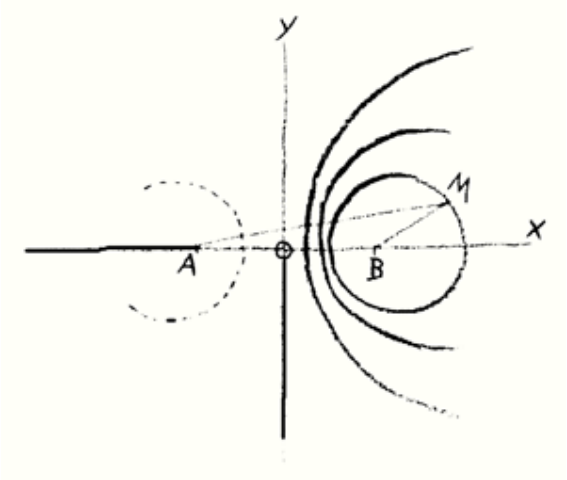

Fig. 8

(it could of course be expressed in some other way), we always obtain corresponding values in the equation, and we can find the circle. In doing this we find different forms of the circle (that is, different proportions between the radius of the circle and the length of the straight line AB), according to the proportion of m to n. These different forms of the circle behave in such a way that their curvature becomes less and less. When n is much greater than m, we find a circle with a very strong curvature; when n is not so much greater, the curvature is less. The circle becomes larger and larger the smaller the difference between n and m. And if we follow this proportion of m to n still further, the circle gradually passes over into a straight line. You can follow this in the equation. It passes over into the ordinate axis itself. The circle becomes the ordinate axis when m = n, that is, when the quotient m/n = 1. In this way the circle gradually changes into the ordinate axis, into a straight line.

You need not be particularly astonished at this. It is quite possible to imagine. But something very different happens it we wish to follow the process still further. The circle has flattened more and more, and through becoming flatter from within, as it were, it changes into a straight line. It does this because the constant ratio in the equation undergoes a change. Through this the circle becomes a straight line. But this constant ratio can of course grow beyond 1, so that the arcs of the circles appear here (on the left of the y axis). What must we do, however, if we try to follow it in our imagination? We have to do something quite peculiar. We have, in fact, to think of a circle which is not curved towards the inside, but is curved towards the outside. Of course, I cannot draw this circle, but it is possible to think of a circle which is curved towards the outside.[1] In an ordinary circle the curvature is towards the inside, it is not? If we follow the line round it returns into itself. But defining the circle in this other way, if we use the necessary constant, we obtain a straight line. The curvature is still on this side (right of the y axis). But it now makes things not nearly so comfortable for us as before! Previously, the curvature always turned towards the center of the circle, while now (in the case of the straight line), we are shown that the center is somewhere in the infinite distance, as one says. Following on from this, there arises for us the idea of a circle which is curved towards the outside. Its curvature is then no longer as it is here (Fig. 9a) — that would be the ordinary, commonplace, philistine circle, — but its curvature is here (Fig. 9b). Therefore, the inside of this circle is not here; this is the outside; the inside of this circle (Fig. 9c) is to the right.

Now compare what I have just put before you. I have described the curve of Cassini, with its various forms, the lemniscate and the form in which there are two branches. And now we have pictured the circle in such a way that at one time it is curved in the familiar way, with the inside here and the outside here; while in a second form of circle (in drawing it we are only indicating what is meant) we find that the curvature is this way round, with an inside here and an outside here.

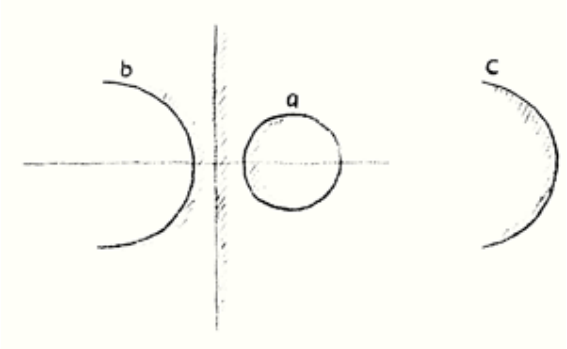

Fig. 9

Comparing it with the Cassini curve, the first form of the circle would correspond to the closed forms, as far as the lemniscate. After this we have another kind of circle, which must be thought of in the other direction, being curved this way, with the inside here and the outside here. You see, when we are concerned with the constant product we find forms of the curve of Cassini where, it is true, we are thrown out of space, yet we can still draw the other branch on the other side. The other branch is once more in space, although in order to pass from the one to the other we are thrown out of space. Here, in the case of the circle, however, the matter becomes still more difficult. In the transition from circle to straight line we are, indeed, thrown out of space, and moreover, we can no longer draw a self-contained form at all. This we are unable to do. In passing over from the curve of constant product to the curve of constant quotient, we are only just able to indicate the thought spatially.

It is extraordinarily important that we concern ourselves with the creating of ideas which, as it were, will still slip into such curve-forms. I am convinced that most people who concern themselves with mathematics take note of such discontinuities, but then make the thought more comfortable by simply holding to the formula and not passing on to what should accompany the mathematical formula in true continuity of thought. I have also never seen that in the treatment of Mathematics as subject matter for education any great value is laid upon the forming of such thoughts in imagination. — I do not know, — I ask the mathematicians present, Herr Blümel, Herr Baravalle, if this is so; whether in modern University education any importance is attached to this? (Dr. Unger here mentioned the use of the cinema.) Yes, but that is a pretense. It is only possible to represent such things within empirical space by means of the cinema or in similar ways, it some sort of deception is introduced. It cannot be pictured fully in real space without the effect being achieved through some form of deception. The point is, whether there is anywhere in the sphere of reality something which obliges us to think realistically in terms of such curves. This is the question I am now asking. Before passing on, however, to describe what might perhaps correspond to these things in the realm of reality, I should like to add something which may perhaps make it easier for you to pass transition from these abstract ideas to the reality. It is the following.

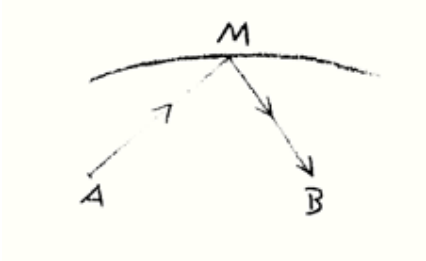

Fig. 10

You can set another problem in the sphere of theoretical Astronomy, theoretical Physics. You can say: Let us suppose that here as A, is a source of light, and this source of light in a illumines a point M (Fig. 10). The strength of the light shining from M is observed from B. That is, with the necessary optical instruments, observation is made from B of the strength of the light shining from the point M,

which is illumined from A. And of course, the strength of the light would vary, according to the distance between B and M. But there is a path which could be described by the point M, such that, being illumined from A, it always shines back to B with the same intensity. There is such a path; and we can therefore ask: What must be the locus of a point, illumined from a fixed point A, such that, seen from another fixed point B, its light is always of the same intensity? This curve — the curve in which such a point would have to move — is the curve of Cassini! From this you see that something which takes on a qualitative nature is set into spatial connection, fitting into a complicated curve. The quality that we must see in the beam of light — for the intensity of light is a quality — depends in this case on the element of form in the spatial relationships.

I only wished to bring this forward for you to see that there is at least some way of leading over from what can be grasped in geometrical form to what is qualitative. This way is a long one, and what we will now discuss is something to which I want to draw your attention, although it would take months to present in all detail. You must be fully aware that I only intend to give you guiding lines; it is left to you to develop them further and to go into all the details which would testify to the truth of what is said. For you see, the connection which must be formed between spiritual science and empirical sciences of today demands very far-reaching and extensive work. But when lines of direction are once given, this work can to some extent be undertaken and carried forward. It is at all events possible. One must only be able in a quite definite way to penetrate into the empirical phenomena.

If we now tackle the problem from quite another angle, — we have sought to some degree to understand it from the mathematical aspect, then, to anyone who is studying the human organism, there is something which cannot escape unnoticed, something which has often been brought forward in our circle, especially in the talks which accompanied the course of lectures on Medicine in Dornach in the spring of 1920. It is not to be overlooked that certain relationships exist between the organisation of the head and the rest of the human organisation, for example the metabolism. There is indeed a connection, indefinable to begin with, between what takes place in the third system of the human being — in all the organs of metabolism — and what takes place in the head. The relationship is there, but it is hard to formulate. Clearly as it emerges in various phenomena, — for example, it is obvious that certain illnesses are connected with skull or head deformities and the like, and these things can easily be traced by one who tries to follow them with biological reasoning, — it nevertheless difficult to grasp this relationship in imagination. People do not usually get beyond the point of saying that there must be some sort of connection between what takes place in the head, for instance, and in the rest of the human organism. It is a picture which is difficult to form, just because it is so very hard for people to make the transition from the quantitative aspect to the qualitative. If we are not educated through spiritual-scientific methods to find this transition, quite independently of what outer experience offers, — to extend to what is qualitative the kind of thought we use for what is quantitative, if we do not methodically train ourselves to do this, then, my dear friends, there will always be an apparent limit to our understanding of the external phenomena.

Let me indicate but one way in which you can train yourselves methodologically to think the qualitative in a similar way as you think the quantitative. You are all acquainted with the phenomenon of the solar spectrum, the usual continuous spectrum. You know that we have there the transition of colour from red to violet. You know, too, that Goethe wrestled with the problem of how this spectrum is in a sense the reverse of what must arise if darkness be allowed to pass through the prism in the same way as is usually done with light. The result is a kind of inverted spectrum, and as you know Goethe arranged this experiment also. In the ordinary spectrum, the green passes over on the one side towards the violet and on the other towards the red; whereas in the spectrum obtained by Goethe in applying a strip of darkness to the prism there is peach-blossom in the middle and then again red on the one side and violet on the other (Fig. 11). The two colour bands are obtained, the centres of which are opposite to one another, qualitatively opposite, and both bands seem to stretch away as it were into infinity. But now, one can imagine that this axis, the longitudinal axis of the ordinary spectrum, is not simply a straight line, but a circle, as indeed every straight line is a circle. If this straight line is a circle, it returns into itself, and we can consider the point where the peach-blossom appears to be the

same point as the one in which the violet, stretching to the right, meets the red, which stretches to the left. They meet in the infinite distance to the right and left. If we were to succeed — maybe you know that one of the first experiments to be made in our newly established physical laboratory is to be in this direction — if we were to succeed in bending the spectrum in a certain way into itself, then even those who are not willing to grasp the matter to begin with in pure thought will be able to see that we are here concerned with something real and of a qualitative nature.

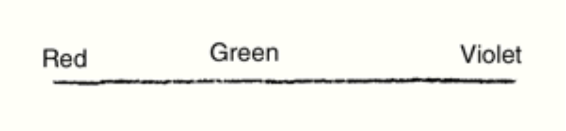

Fig. 11

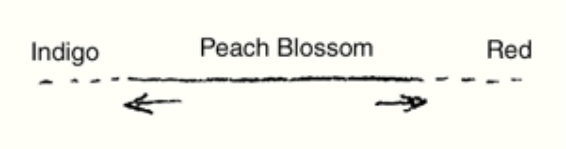

Fig. 12

We come to certain limiting ideas in Mathematics, where — as in Synthetic Geometry — we are obliged to regard the straight line as a circle in a quite real though inner sense; where we are obliged to admit of the infinitely distant point of a straight line as being only one point; or to understand as bounding a plane, not some line above and then again below, but a single straight line; or to think of the boundary of infinite space, not in the nature of something spherical, but as a plane. Such ideas, however, also become, in a way, limiting ideas for sense-perceptible empirical reality, and we are made to realise it if we insist on restricting ourselves to sense-perceptible reality.

This brings us to something which would otherwise always remain perpetually in the dark. I have already mentioned it. It invites us really to think-through the thought-pictures to which we come when we allow the lemniscate-form of the Cassini curve to pass over into the double-branched form, — the form with the two branches for which we must go out of space, — and them compare this with what confronts us in the empirical reality.

You are indeed already doing this, my dear friends, when you apply Mathematics in one way or another to the empirical reality. You call a triangle a triangle, because you have first constructed it mathematically. You apply to the outer form what has been evolved in an inner constructive way within you. The process I have just described is only more complicated, but it is the same process when you think of the two branches of that particular form of the Cassini curve as one. Apply this thought to the correspondence between the human head and the rest of the human organism and you will have to realise that in the head there is a connection with the remaining organism of precisely such a character as is expressed by the equation which requires, not a continuous curve, but a discontinuous one. This cannot be followed anatomically; you must go out beyond what the body comprises physically, if you would find the connection of what comes to expression in the head with what comes to expression in the metabolic system. It is essential to approach the human organism with thoughts which are quite unattainable if for every element of the thought you insist on an entire correspondence within the sense-perceptible empirical realm. We must reach out to something else, beyond the sense-perceptible empirical realm, if we are to find what this relationship really is within the human being.

Such a study, if one really gives oneself up to it and carried it out methodically, is extraordinarily rich in its results. The human organisation is of such a nature that it cannot be embraced by the anatomical approach alone. Just as we are driven out of space in the Cassini curve, so in the study of man we are driven out of the body, by the method of study itself. You see, it is quite possible to understand in the first place in thought, that in a study of the whole man we are driven out of the realm

of what can be grasped in a physical-empirical sense. To put forward such things is no offence against scientific principles. Such ideas are far removed from the purely hypothetical fantasies which are often entertained in connection with natural phenomena, for they refer to the whole way in which man is membered into the universe. You are not looking for something which is otherwise non-existent, but rather for something which is exactly the same as what is expressed in the relationship between a man thinking mathematically and the empirical reality.

It is not a question of looking for hypotheses which in the end are unjustifiable; it is a question, since the reality is obviously complicated, of looking for other cognitive relations to the inner reality, in addition to the simple relation of mathematical man to empirical reality. When once you have accepted such thoughts, you will also be led to ask whether what takes place outside the human being in other domains besides the astronomical, — for example, in those phenomena which we call the chemical and physical, — whether those same phenomena, which we regard as chemical phenomena outside of man, take the same course within man, when he is alive, as they do outside him, or whether here, too, a transition is necessary which leads in some way out of space.

Now consider the important question arising out of this. Suppose we have here some kind of chemical phenomena and here the boundary leading over to the inside of the human being (Fig. 13). Supposing that this chemical phenomenon were able to call forth another, so that the human being reacted here (inside); then, if we remain in the field of the empirical, space would of course be the mediator. If, however, the continuance of this phenomenon within the human being comes about by virtue of the fact, say, that the human being is nourished by food, and the processes already taking place outside him continue inside him, then the question arises: Does the force which is at work in the chemical process remain in the same space when it taking place within man as when it is taking its course outside him? Or must we perhaps go out of space?

And there you have what is analogous to the circle which changes over into a straight line. If you look for its other form, where what is usually turned outward is now turned inward, you are entirely outside of space.

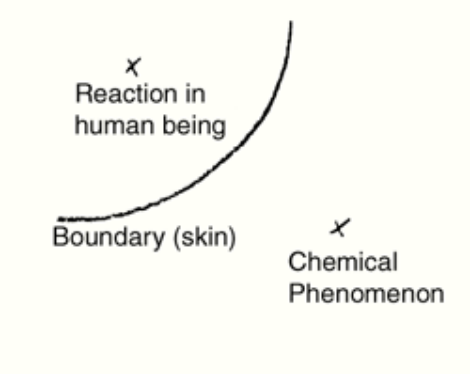

Fig. 13

The question is, whether we do not need such ideas as these, thought-pictures which, while remaining continuous, go right out of space, — when we follow the course of what happens outwardly, outside of man, into the interior of the human being. The only thing to be said against such things, my dear friends, is that they certainly impose greater demands on the human capacity of understanding than the ideas with which he phenomena are approached today. They might therefore be rather awkward in University education. They are, no doubt, thoroughly awkward, for they imply that before approaching the phenomena we must awaken in ourselves what will enable us to understand them. Nothing like this exists in our educational system today; but it must come, it must certainly come, otherwise simply in speaking of a phenomenon we get into the greatest disparities, without in any way seeing the reality. Just think what happens when someone observes the circle as it curves to this side (Fig. 9a), and then sees how it curves to this side (Fig. 9b), but then remains a philistine and

simple does not conceive that the circle now curves towards the other side. He says: This is impossible, the circle cannot curve this way; I must put the curvature this way round, I must simply place myself on the other side. What he is speaking about seems to be one and the same thing; but he has changed his point of view.

In this way today we make matters simple, in describing what is within the human being in comparison with what takes place in Nature outside him. We say: What is within man does not exist at all; I must simply place myself within man and say that the curvature is facing this way (Fig. 9c). I will then consider what is inside, without taking into account that I have reversed the curvature. I will make the interior of the human being into an outer Nature. I simply imagine outer Nature to continue through the skin into the interior. I turn myself round, because I am not willing to admit the other form of curvature, and then I theorise. That is the trick which is performed today, only in order to adhere to more comfortable motions. There is no desire to accent what is real; in order not to have to do so, we simply turn ourselves round, and — this is now a comparison — instead of looking at the human from in front, we look at Nature from behind and thus arrive in this way at all the various theories concerning man.

We will continue, then, tomorrow.

Notes:

1. If it were drawn it would look like an ordinary circle, only one would have to bear in mind that “outside” and “inside” had changed places. (Editor's note.)

Lecture X
Stuttgart, January 10, 1921

My Dear Friends,

Taking my start yesterday from certain considerations in the realm of form, I showed how the connections should be thought of between the processes of the human metabolic system and the processes of the head, the nervous system, or whatever you wish to call it in the sense of the indications given in my book 'Riddles of the Soul' ("Von Seelenratseln").

It would be regarded as quite out of the question to study the movements of a magnet-needle on the Earth's surface in such a way as to try to explain these movements solely out of what can be observed within the space occupied by the needle. The movements of the magnet-needle are, as you know, brought into connection with the magnetism of the Earth. We connect the momentary direction of the needle with the direction of the Earth's magnetism, that is, with the line of direction which can be drawn between the north and south magnetic poles of the Earth. When it is a question of explaining the phenomena presented by the magnetic needle, we go out of the region of the needle itself and try to enter, with the facts that have been collected towards an explanation, into the totality which alone affords the opportunity to explain phenomena, the manifestations of which belong to this totality. This rule of method is certainly observed in regard to some phenomena, — to those, I should say, the significance of which is fairly obvious. But it is not observed when it is a question of explaining and understanding more complicated phenomena.

Just as it is impossible to explain the phenomena of the magnetic needle from the needle itself, it is equally and fundamentally impossible to explain the phenomena relating to the organism from out of the organism itself, or from connections which do not belong to a totality, to a whole. And just for this reason, because there is so little inclination to reach the realm of totalities in order to find explanations, we arrive at those results put forward by the modern scientific method in which the wider connections are almost entirely left out of the picture. This method encloses the phenomena, whatever they may be, within the field of vision of the microscope; while the celestial phenomena are restricted to what is observable externally, with the help of instruments. In seeking for explanations, no attempt is made to consider the necessity of reaching out to the surrounding totality within which a phenomenon is localised. Only when we become familiar with this quite indispensable principle of method, are we in a position to bring our judgment to bear upon such things as I was describing to you yesterday. Only in this way shall we grow able to estimate how such realms of phenomena as are met within the human organism will appear, when truly recognised in the totality to which they properly belong.

Remember what I described at the very beginning of this course of lectures. I drew your attention to the fact that the principle of metamorphosis as it appeared first in the work of Goethe and Oken must be modified if it is truly to be applied to man. The attempt was made — and it was made with genius on the part of Goethe — to derive the formation of the bones of the skull from that of the vertebrae. These investigations were continued by others in a way more akin to 19th-century method, and the progress of the method of investigation (I will not now decide whether it was a step forward or not) can be studied by comparing how this problem of the metamorphosis of one form of bone into another was conceived on the one hand by Goethe and Oken and on the other, for example, by the anatomist Gegenbauer.

These things are only to be set on a real basis, if one knows (as I said, I have already mentioned this in the course of these lectures, but we will now link on to it again) how two types of bone in the human organism (not the animal, but the human organism), most widely separated from the point of view of their morphology, are actually related to one another. Bones far removed from one another in the aspect of their form would be a tubular or long bone — femur or humerus, for example, — and a

skull-bone. To make a superficial comparison, without really entering into the inner nature of the form and bringing a whole range of phenomena into connection with it, is not enough to reveal the morphological relationship between two polar opposite bones — polar opposite, once more, in regard to their form. We only begin to perceive it if we compare the inner surface of a tubular bone with the outer surface of a skull-bone. Only thus do we get the true correspondence (Fig. 1) which we must have in order to establish the morphological relation. The inner surface of the tubular bone corresponds morphologically to the outer surface of the skull-bone. The skull-bone can be derived from the tubular bone if we picture it as being reversed, to begin with, according to the principle of the turning-inside-out of a glove. In the glove, however, when I turn the outer surface to the inside and the inner to the outside, I get a form similar to the original one. But if in the moment of turning the inside of the tubular bone to the outside, certain forces of tension come into play and mutual relationships of the forces change in such a way that the form which was inside and has now been turned outward alters the shape and distribution of its surface, then we obtain, through inversion on the principle of the turning-inside-out of a glove, the outer surface of the skull bone as derived from the inner surface of the tubular bone. From this you can conclude as follows. The inner space of the tubular bone, this compressed inner space, corresponds in regard to the human skull to the entire outer world. You must consider as related in their influence upon the human being: The outer universe, forming the outside of his head, and what works within, tending from within toward the inner surface of the tubular bone. These you must see to belong together. You must regard the world in the inside of the tubular bone as a kind of inversion of the world surrounding us outside.

Fig. 1

There, for the bones in the first place, you have the true principle of metamorphosis! The other bones are intermediary forms; morphologically, they mediate between the two opposite extremes, which represent a complete inversion, accompanied by a change in the forces determining the surface. The idea must however be extended to the entire human organism. In one way, it comes to expression most clearly in the bones; but in all the human organs we must distinguish between two opposing factors, — that which works outward from an unknown interior, as we will call it for the moment, and that which works inward from without. The latter corresponds to all that surrounds us human beings on the planet Earth.

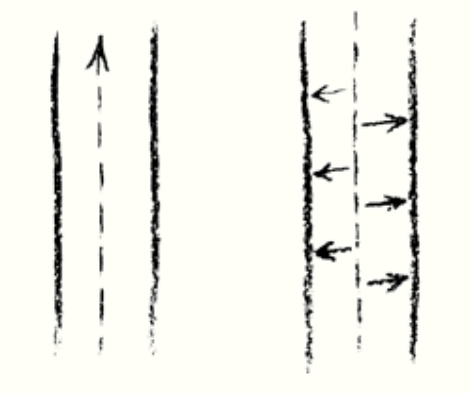

Fig. 2 Fig. 3

The tubular bone and the skull-bone represent indeed a remarkable polarity. Take the tubular bone and think of this centre-line (Fig. 2). This line is in a way the place of origin of what works outward, in a direction perpendicular to the inner surface of the bone (Fig. 3). If you now think of what envelops the human skull, you have what corresponds to the central line of the tubular bone. But how must you draw the counterpart of this line? You must draw it somewhere as a circle, or more exactly, as a spherical surface, far way at some indeterminate distance (Fig. 4). All the lines which can be drawn from the centre-line of the tubular bone towards it inner surface (Fig. 3) correspond, in regard to the skull-bone, to all the lines which can be drawn from a spherical surface as though to meet in the centre of the Earth (Fig. 4). In this way you find a connection — approximate, needless to say — between a straight line, or a system of straight lines, passing through a tubular bone and bearing a certain relation to the vertical axis of the body, the direction of which coincides, in fact, with that of the Earth's radius and a sphere surrounding the Earth at an indeterminate distance. In other words, the connection is as follows. The radius of the Earth has the same cosmic value in regard to the vertical posture of the human organism, perpendicular to the surface of the Earth, as a spherical surface, a cosmic spherical surface has in regard to the skull organisation. This, however, is the same contrast which you experience within yourself if you make yourself aware of the feeling of being inside your own organism and experiencing of the outer world at the same time. This is the polarity you reach if you compare your feeling of self — that feeling of self which is really based on the fact that in normal life you can depend upon your bodily organisation, that you do not become giddy, but keeping a right relation to the force of gravity — with all that is present in your consciousness in connection with what you see around you through the senses, even as far away as the stars.

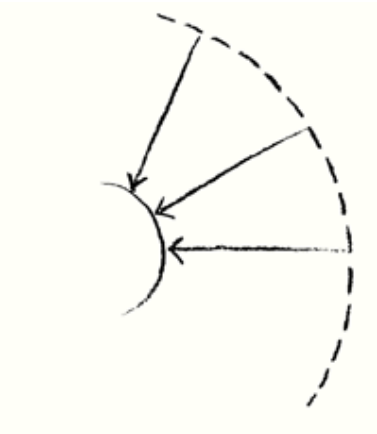

Fig. 4

Putting all this together, you will be able to say: There is the same relation between this feeling of being in yourself and the feeling of consciousness you have in perceiving the outer world as there is between the structure of your body and of your skull. We are thus led to the relationship between what we might call: Earthly influence upon man, of such a character that it works in the direction of the Earth's radius, and what we might call: The influence which makes itself felt in the entire circumference of our life of consciousness, and which we must look for in the sphere, in what really is for us the inner wall, the inner surface, of a hollow sphere. This polarity prevails in our normal day-waking conscious life. It is this polarity which, roughly speaking — if we leave out of account what is in our consciousness as a result of observating our earthly environment — we may look upon as the contrast between the starry sphere and earthly consciousness, earthly feeling of ourselves, — Earth-impulse living in us. If we compare this impulse of Earth, this radial Earth-impulse, to our consciousness of the vast sphere, — if we observe how this polarity, prevails in normal waking consciousness, we shall perceive that it is always there, living in us, playing its part in our conscious life. We live far more in this polarity than we are wont to think. It is always present and we live within it. The connection between the forming of mental images and the life of will can be really studied in

no other way than by considering the contrast between ‘sphere’ and ‘radius’. In psychology, too, we should come to truer results with regard to the connection of our world of ideas and mental pictures, manifold and extensive as it is, with the more unified world of our will, if a similar relationship were sought between them as is symbolised in the relation of the surface-area of a sphere with the corresponding radius.

Now, my dear friends, let us look at all this which is at work in our day-waking consciousness, forming the content of our soul-life, let us now consider how it takes its course when we are in quite a different situation. In effect, how does it work upon us during the time of the embryonic life? We can well imagine, indeed we must imagine that the same polarity will be at work here too, only in another way. During the embryonic period, we do not direct towards the outer world the same activity which afterwards dims down this polarity to a pictorial one; at this time, the polarity affects all that is formative in our organisation, in a much more real way than when, in picture form, it becomes active in our life of mind and soul. If therefore we project the activity of consciousness back in time to the embryonic period, then one might say that in the embryonic life we have what we otherwise have in the activity of consciousness, but we have it at a more intensive, more realistic stage. Just as we clearly see the relation of sphere and radius in our consciousness, so to reach any real result, we must look for this same polarity of heavenly sphere and earthly activity in what happens in the embryonic life. In other words, we must look for the genesis of human embryonic life by finding a resultant between what takes place out in the starry world — an activity in the ‘sphere’ — and what takes place in man as a result of the radial Earth-activity.

What I have just described must be taken into account with the same inner necessity of method as the Earth's magnetism is in connection with the magnetic needle. There may be much that is hypothetical even in this, but I will not go into it now. I only wish to point out: We have no right to restrict our considerations to the embryo alone, — to explain the processes taking place within it simply out of the embryo itself. In just the same way as we have no right too explain the phenomenon of the magnet out of itself alone, so too, we have no right to explain the form and development of the embryo purely on the basis of the embryo itself. In attempting to explain the embryo we must take these two opposites into account. As we take the Earth's magnetism into account in connection with the magnet, so must we observe the polarity of sphere and radial activity, in order to understand what is developing in the embryo, — which, when the embryo is born, fades into the pictorial quality of the experience of consciousness. The point is, we must learn to see the relationship which exists in man between tubular or long bone and skull-bone in the other systems too — in muscle and nerve, and so on; — and when we do study this polarity, we are led out into the life of the Cosmos. Consider how closely related (as described in my book “Riddles of the Soul”) is the whole essence and content of the human metabolic system with what I have now characterised as being under the influence of the ‘radial’ element, and how closely related is the head system to what I have just described as being under the influence of the ‘sphere’. Then you will say: We must distinguish in the human being what conditions his sensory nature and what conditions his metabolic life; moreover, these two elements are related to one another as heavenly sphere to earthly activity.

We must therefore look for the product of the celestial activity in what we bear in our head organisation and for what unites to a resultant with this, the activity belonging to the Earth — tending, as it were, towards the centre of the Earth — in our metabolism. These two realms of activity and influence fall apart in man; it is as thought they represent two Ice Ages, and the middle realm, the rhythmic realm, mediates between them. In the rhythmic system we actually have something, — if I may so express myself, — which is a realm of mutual interplay between Earth and Heaven.

And now if we wish to go further, we must consider various other relationships which reveal themselves to us in the realm of reality. I will now draw your attention to something very intimately connected with what I have just been describing.

There is the familiar membering of the outer world which surrounds us and to which we as physical man belong; we divide it into mineral kingdom, plant kingdom, animal kingdom, and regard man as

the culmination of this external world of Nature. Now, if we would obtain a clearer view of what we have described in connection with the working of the celestial phenomena, we must turn our attention to yet another thing.

It is not to be denied — it is indeed quite obvious to any prejudiced observer — that with our human organisation as it is now, in the present phase of the cosmic evolution of humanity, we are, in regard to our capacities of knowledge, entirely adapted to the mineral kingdom. Take the kind of laws we seek in Nature; and you will agree that we are certainly not adapted to all aspects of our environment. To put it curtly, all that we really understand is the mineral kingdom. Hence all the efforts to refer the other kingdoms of Nature back to the laws of the mineral domain. After all, it is because of this that such confusion has arisen with regard to mechanism and vitalism. To the ordinary view which is ours toady, life remains either a vague hypothesis, as it was in earlier times, or else its manifestations are explained in terms of the mechanical, the mineral. The ideal, to reach an understanding of life, is unaccompanied by any recognition of the fact that life must be understood as life; on the contrary, the fundamental aim is to refer life back to the laws of the mineral realm. Precisely this betrays a vague awareness of the fact that man's faculties of knowledge are only adapted to understand the mineral kingdom and not the plant nor animal.

Now when we study on the one hand the mineral kingdom itself and on the other hand its counterpart, namely, our own knowledge of the mineral kingdom, in that these two correspond to one another, we shall be compelled, — since as explained just now we must relate all our life of knowledge to the heavenly sphere, also to bring into connection with the heavenly sphere, in some way, that to which our knowledge is related, namely the mineral kingdom. We must admit: In regard to our head organisation, we are organised from the celestial sphere; therefore what underlies the forces of the mineral kingdom must also be organised from the celestial sphere in some way. Compare then what you have to your sphere of understanding — the whole compass of your knowledge of the mineral kingdom — with what is actually there in the mineral kingdom in the outer world, and you will be led to say: What is thus within you relates to what is in the mineral kingdom outside you, as picture to reality.

Now we must think of this relationship more concretely than in the form of picture and reality, and we are helped to do so by what I said before. Our attention is drawn to what underlies the human metabolic system and to the forces active there, forces which are connected with the pole of earthly activity, typified by the radius. In seeking for the polar opposite, within ourselves, to that part of our organisation which forms the basis for our life of knowledge, we are directed from the encompassing Sphere to the Earth. The radii converge to the middle point of the Earth. In the radial element we have something by which we feel ourselves, which gives us the feeling of being real. This is not what fills us with pictures in which we are merely conscious; this is what gives us the experience of ourselves as a reality. When we really experience this contrast, we come into the sphere of the mineral kingdom. We are led from what is organised only for the picture to what is organised for the reality. In other words: In connection with the cause and origin of our life of knowledge, we are led to the wide, encompassing sphere, — we concave it in the first place as a sphere, — whereas, in following the radii of the sphere towards the middle of the Earth, we are led to the middle point of the Earth as the other pole.

Thinking this out in more detail, we might say: Well, according to the Ptolemaic conception for example, out there is the blue sphere, on it a point (Fig. 5) — we should have to think of a polar point in the centre of the Earth. Every point of the sphere would have its reflected point in the Earth's centre. But, or course, it is not to be understood like that. (I shall speak more in detail later on; to what extent these things correspond exactly is not the question for the moment.) The stars, in effect, would be here (Fig. 6). So that in thinking of the sphere concentrated in the centre of the Earth, we should have to think of it in the following way: The pole of this star is here, of this one here, and so on (Fig. 6). We come, then, to a complete mirroring of what is outside in the interior of the Earth.

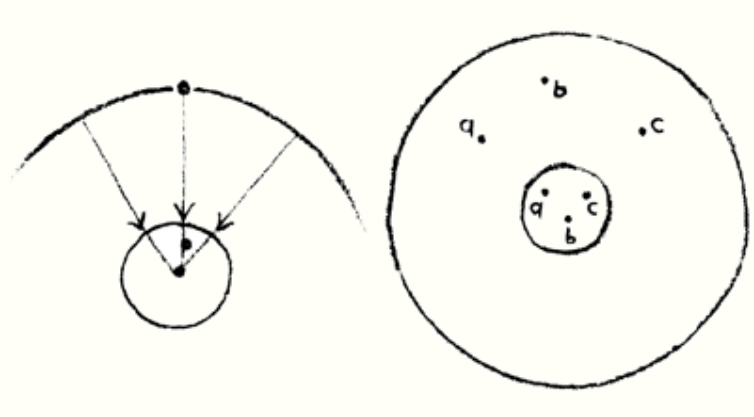

Fig. 5 Fig. 6

Picturing this in regard to each individual planet, we have, say, Jupiter and then a polar Jupiter' within the Earth. We come to something which works outward from within the Earth in the way that Jupiter works in the Earth's environment. We arrive at a mirroring (in reality it is the opposite way round, but I will now describe it like this), a mirroring of what is outside the Earth into the interior of the Earth. And if we see the effect of this reflection in the forms of the minerals then we must also see the effect of what works in the cosmic sphere itself in forming our faculty of understanding the minerals. In other words: We can think of the whole celestial sphere as being mirrored in the Earth: We conceive the mineral kingdom of the Earth as an outcome of this reflection, and we conceive that what lives within us, enabling us to understand the mineral kingdom, comes from what surrounds us out in the celestial space. Meanwhile the realities we grasp by means of this faculty of understanding come from within the Earth.

You need only follow up this idea and then cast a glance at man, at the human countenance, and, if you really look at this human countenance, you will hardly be able to doubt that in it something is expressed of the celestial sphere, and that there also appears in it what is present as pictorial experience in the soul, namely the forces which rise up into the realm of soul activity from the realm of bodily activity, after having been at work more intensively in this bodily realm during embryonic life. Thus we find a connection between what is out side us in outer reality, and our own organisation for the understanding of this outer reality. We can say: The cosmos produces the outer reality, and our power to understand this outer reality is organised physically by virtue of the fact that the cosmic sphere is only active in us now for our faculty of knowledge. Therefore we must distinguish, in the genesis of the Earth as well, between two phases: One in which active forces work in such a way that the real Earth itself is created, and then a later phase of evolution, in which the forces work so as to create the human faculty for understanding the realities of the Earth.

Only in this way, my dear friends, do we really come near to an understanding of the Universe.

You may say: Well and good, but this method of understanding is less secure than the method used today with the aid of microscope and telescope. It may be that to some people it appears less secure. But if things are so constituted that we cannot reach the realities with the methods in favour today, then we are faced with the absolute necessity of comprehending the reality with other modes of understanding and we shall have to get used to developing those other methods. It is of no avail to say, you will have nothing to do with such lines of thought, since they appear too uncertain. What if this degree of certainty alone were possible! However, if you really follow up this line of thought, you will see that the degree of certainty is just as great as in your conception of a real triangle in the outer world when you take hold of it in thought with the inner idea of construction of a triangle. It is the same principle, the same manner of comprehending outer reality in the one case as in the other. This should be borne in mind.

Certainly, the question arises: Taking these thoughts, as I have here developed them, it is possible to become clear in a general way about such connections, but how can one reach a more definite comprehension of these things? For only in a much more definite form can they be of use in helping us to grasp the realm of reality. In order to go into this, I must draw your attention to something else.

Let us return to what I aid yesterday, for example, in regard to the Cassini curve. We know that this curve has three, or, if you like, four forms. You remember, the Cassini curve is determined as follows. Given two points A and B, I will call the distance between them 2a; then any point of the curve will be such that AM — MB = b2, that is, a constant. And I obtain the various forms of the Cassini Curve according to whether a, that is, half the distance between the foci, is greater than, equal to, or less than b. I obtain the lemniscate when a = b, and the discontinuous curve when a is greater than b.

Imagine now that I wanted not only to solve this geometrical problem, assuming two constant magnitudes a and b and then setting up equations to determine the distances of M from A and B. Suppose I wanted to do more than this, namely, to move in the plane from one form of line or curve to another by treating as variable magnitudes those magnitudes which remain constant for a particular curve. In the picture (Lecture IX, Fig. 3) after all, we only envisaged certain limiting positions with a greater or smaller than b. Between these there are an infinite number of possibilities. I can-pass over quite continuously to the construction of one form of the Cassini curve after another. And I shall obtain these different forms if, let us say, to the variability of the first order, say between y and x. I add a variability of the second order; that is, if I allow my construction of the curves as they pass over from one to the other continuously, to take its course in such a way that a remains a function of b.

What am I doing when I do this? I am constructing curves in such a way that I create a continuous, moving system of Cassini curves passing over via the lemniscate into the discontinuous forms, not at random, but by basing it on a variability of the second order, in that I bring the constants of the curves themselves into relationship with one another so that a is a function of b, $a = \varphi(b)$. Mathematically, it is of course perfectly feasible. But what do we obtain by it? Just think, by means of it I obtain the condition for the character of a surface such that there is a qualitative difference even mathematically speaking, in all its points. At every point another quality is present. I cannot comprehend the surface obtained like this in the same way as I comprehend some abstract Euclidean plane. I must look upon it as a surface which is differentiated within itself. And if by rotation I create three-dimensional forms then I should obtain bodies differentiated within themselves.

If you think of what I said yesterday, namely, that the Cassini Curve is also the curve in which a point must move in space if, illuminated from a point B, it reflects the light to a point A with constant intensity; and if you also bear in mind that the constancy underlying the curve here brings about a relation between the effects of light at different points; then, just as in this instance certain light-effects result from the relation of the constants, so one can also imagine that a system of light-effects would follow if a variability of the second order were added to the variability of the first. In this way you can create, even in mathematics itself, a process of transition from the quantitative to the qualitative aspect.

These attempts must indeed be made in order to find a way of transition from quantity to quality, — and this endeavour we must not abandon. For a start can be made from what it is that we are really doing when we form an inner connection between the function within the variability of the second order and the function within variability of the first order. (It has nothing to do with the expression “order”, as it is familiarly used; but you will understand me, as I have explained the whole thing from the beginning.) By turning our attention to this relationship between what I have called first and second order, we shall gradually come to see that our equations must be formed differently, according to whether we are taking into account, for example, what in an ordinary bodily surface lies between the surface and our eye, or what lies behind the surface of the body. For a relationship not unlike this between the variability's of the first order and of the second order, exists between what I must consider as being between myself and the surface of a quite ordinary body and what lies behind the surface of the body. For example, suppose we are trying to understand the so-called reflection of the rays of light,

— what we observe when there is a reflecting surface. It is a process taking place, to begin with, between the observer and the surface of the body. Suppose that I conceive this as a confluence of equations taking their course between me and the surface of the body in a variability of the first order, and then, in this connection consider what is at work behind the surface so as to bring about the reflection as an equation in the variability of the second order. I shall arrive at quite other formulae than are now applied according to purely mechanical laws, — omitting phases of vibration and so on — when dealing with reflection and refraction.

In this way the possibility would be reached of creating a form of mathematics capable of dealing with realities; and it is essential for this to happen, if we would find explanations particularly in the realm of astronomical phenomena. In regard to the external world, we have before us what takes place between the surface of the Earth-body and ourselves. When, however, we contemplate the celestial phenomena — say, a loop of Venus — trivially speaking we also have before us something which takes place between us and some other thing; yet the reality confronting us in this case is in fact like the realm beyond the sphere in its relation to what is within the central point. However we look to the phenomena of the heavens, we must recognise that we cannot study them simply according to the laws of centric forces, but that we must regard them in the light of laws which are related to the laws of centric forces as is the sphere to the radius.

If, then, we would reach an interpretation at all of the celestial phenomena, we must not arrange the calculations in such a way that they are a picture of the kind of calculations used in mechanics in the development of the laws of centric forces; but we must formulate the calculations, and also the geometrical forms involved, so that they relate to mechanics as sphere relates to radius. It will then become apparent (and we will speak about this next time) that we need: In the first place, the manner of thinking of mechanics and phoronomy, which has essentially to do with centric forces, and secondly, in addition to this system, another, which has to do with rotating movements, with shearing movements and with deforming movements. Only then, when we apply the meta-mechanical, meta-phoronomical system for the rotating, shearing and deforming movements, just as we now apply the familiar system of mechanics and phoronomy to the centric forces and centric phenomena of movement, only then shall we arrive at an explanation of the celestial phenomena, taking our start from what lies empirically before us.

Lecture XI
Stuttgart, January 11, 1921

My Dear Friends,

We have now gained the most essential premises for a study of some aspects at least of celestial and also of earthly-physical phenomena. In human nature, once again, we have the very significant contrast (to ascertain which, as you will readily understand, we must leave the animal out of account to begin with) — the contrast between the organisation of the head and that of the metabolic system including the limbs. As we have seen, if we wish to relate Man to the Cosmos, we must assign the metabolic system to what is earthly, — what comes to man in a radial direction. Whereas we must assign the forming of the head to all that derives from the great Sphere, — that sends its lines of influence, as it were from the celestial Sphere towards the centre of the Earth, even as the radius reaches outward with its lines of influence to its surroundings. We saw this in the construction of the typical long bones or tubular bones by contrast to the skull-bones, the latter being sphere-like, or like a sector of a sphere.

Envisaging this difference, we must relate it, to begin with, to what appears to us in the relation of the Earth to the Celestial Sphere. You are of course aware, how the scientific consciousness of our time departs from what the naive human being, untouched by any learning, would judge of the appearance of the celestial sphere, the movements of the stars upon it, and so on. We speak of the 'Apparent aspect' of the celestial vault. In contrast to it, as you know, we have a picture — a World-picture — gained in a fairly complicated way by interpreting the apparent movements, and so on. Upon this picture — the form of picture which has evolved through the great changes in cosmology since the Copernican era — we are wont to base all our considerations of celestial phenomena.

Today I take it to be generally realised that this World-picture does not represent absolute reality. We can no longer maintain: What is presented to us by this picture, say, as the planetary movements or as the Sun's relation to the Planets, is the true form of the underlying reality, while what the eye beholds is mere appearance. I hardly think any competent person would adopt this standpoint nowadays. Yet he will still have a feeling that he at least gets nearer to a true conception when he proceeds from the apparent picture of the celestial movements — fraught, he will say with illusionary factors (yet after all, we must admit, objectively observed) — to the interpretation of it by mathematical Astronomy.

The question now is, do we really gain a comprehensive view of the phenomena in question if we only base our picture of the World on this, the customary kind of interpretation. As we have seen, when we do so we are in fact only basing it on what the head-man ascertains, so to speak. We base it on the aspect which emerges for man's powers of observation, aided perhaps by optical instruments. But as we saw, for a more comprehensive interpretation of the World-picture we must have recourse to all that is knowable by man, of man. We emphasised how to this end the form of man must be seen in the light of a true science of metamorphosis. Then too we must bring in the evolution of man and of mankind. In a word, concerning the celestial phenomena, or some of them at least, we cannot look for enlightenment till in our efforts to interpret them we go as far as this, calling to our aid whatever can be known of man.

Figure 1

Let us then presuppose what we arrived at in former lectures — the kind of qualitative mathematics, learned from the human form and growth and evolution. With this in the background let us take our start from what meets the eye — from what is said to be the mere appearance of the Heavens — asking ourselves how we may find the way to reality? Let us then ask, dear friends: What does the eye behold, what do we learn empirically, by simple observation? Then we can try to fill in the picture with what is given by the whole structure of man, both in morphology and evolution. First we will ask the question as regards those stars which are commonly described as fixed stars. I shall no doubt be repeating what is well-known to most of you, yet we must call it to mind for only by so doing, only from the facts as seen, taking them all together, shall we be able to advance to the ideas.

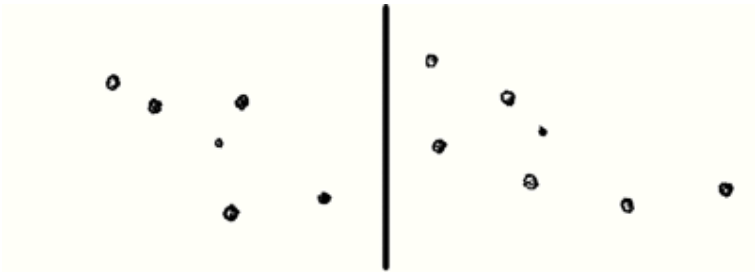

Figure 2 Figure 3

What then do we see as to the movement of the fixed stars, so-called? We must consider longer periods of time, since in short periods the Heaven of fixed stars presents practically the same picture year by year. Only when taking longer epochs do we find that it no longer presents the same uniform picture, but that the whole configuration changes. We can envisage it by taking one example; what we shall find in one region of the Heavens would be found in other regions too. Take then this constellation, which you know so well, the “Great Bear” or “Plough” in the Northern sky. Today it looks like this (Fig. 2). Acquaint yourselves with the minute displacements of the so-called fixed stars which have been ascertained, and which agree with what is shown by very ancient star-maps, although the latter are not always reliable. Sum up the minute displacements and calculate what the constellation will have looked like very long ago, and you get this appearance (Fig. 1). You see, the fixed stars, so-called, have undergone considerable displacements. About 50,000 years ago, if we may reckon it from the minute changes observed, the constellation will have looked like this. If we continue to sum up the ascertainable displacements for the future, — assuming, as we surely may do, that they will continue at least approximately in the same direction — we may conclude that 50,000 years from now the constellation will have this appearance (Fig. 3).

Just as this constellation changes in the course of years — for we have only chosen it as an example — so do the others. Thus when we make our drawings, of the Zodiac for instance in its present form, we must be clear that the form of it changes in the course of time — if we may thus include time in our calculations and in interpreting them.

We must therefore regard the celestial sphere as undergoing changes within itself, ever changing its configuration, — changing the aspect of the starry Heavens which we behold in the fixed stars, — though the perpetual change is scarcely perceptible in shorter periods. Naturally, our observations here cannot go very far, nor can we do very much by way of interpretation, though as some of you will know, modern experiments enable us to ascertain even those movements of the stars which are along the line of sight, — towards us or away from us. Yet it remains very difficult to interpret the ever-changing aspect of the starry heavens. In the further course we shall be asking, what human value and significance is to seek in the interpretation.

Having considered the movements of the fixed stars, let us now ask after the movements of the planetary stars. The movement of the planetary stars as we behold it is indeed complicated. The

movement we observe is such that if we follow the path of a planet, in so far as it is visible, we see it moving in a curve of peculiar shape — different for the different planets and different too for the same planet at different times. From this we have to take our start. Take for example the planet Mercury. Precisely when it is nearest to us, its path is of peculiar form. In a certain direction it seems to move across the Heavens. Study it daily when visible, we see it moving thus; but them it turns and makes a loop, and then goes on as I am showing (Fig. 4). [[1]] It makes one such loop in a so-called synodical period of revolution. This then we may describe as the movement of Mercury — to begin with at least, so far as observation is concerned. The rest of the path is simple, only at certain places do the loops occur.

Figure 4

Figure 5

Passing to Venus we have a similar phenomenon, though somewhat different in shape and form. Venus moves onward thus, then turns and then moves on, thus (Fig. 5). Here as a rule there is only one loop in the course of a year, and, once again, when the planet — as we conclude from other astronomical data — is nearest to us. Now to Mars: Mars has a similar path, only flatter. We may draw it somewhat like this (Fig. 6). In this case, you see, the loop is more compressed, but the appearance is still that of a loop, — distinctly so. Often however the path (both of this and other planets) is so formed that the loop is completely dissolved, flattened away until it is no more. The path is loop-like, though not an actual loop. (Fig. 7) We will pass by the planetoids, interesting though they are, and look at Jupiter and Saturn. We find them too describing loops or loop-like paths. They again do it when nearest the Earth — and only once a year. As a general rule they make a single loop each year.

Figure 6

Figure 7

We have then to consider certain movements on the part of the fixed stars, and the movements of planets. The movements of fixed stars occupy gigantic periods, judged by our standards of time. The movements of the planets comprise a year or fractions of a year and reveal from time to time strange deviations from their ordinary path, loop-lines of movement, in effect. The question now is, what are we to make of these two kinds of movement? How to interpret the loop-movement for example? It is a

very big question. Only the following reflection can lead towards any kind of interpretation of the loop-movements.

In all our human observation the fact is that we are quite differently related to our own conditions and to those things which are not our own; — which take place apart from us, outside us, so to speak. You need only recall how it is with objects: The enormous difference between your relation to any object of the so-called outer world and to an object inside yourself, which you, so to speak, are sharing-in with your own inner experience. If you have any object before you, you see it, you observe it. What you yourself are living in — your liver, your heart, even your sense-organs to begin with you can observe. There is the same contrast, though not quite so strongly marked, with regard to the conditions in which we are living in the outer world. If we ourselves are in movement and if it is possible for us to remain unconscious of how we bring about the movement, then we may well be unaware of our own movement and therefore leave it out of account in judging outer movements. That is to say, though we ourselves are in movement, we leave this out; we deem ourselves at rest and envisage only the external movement.

It is on this reflection, in the main, that the interpretation of movements amid the celestial phenomena has been based. You are aware, it has been argued: Man, at a certain point on Earth, shares of course in the spatial movement of his earthly habitation (eg the circling movement of his latitude) but knows it not and hence regards, what he sees happening in the Universe outside him, as a real movement in the opposite direction. The argument has been abundantly made use of! The question now is: How might this principle be modified if we take into account that in man's organized (if I may so express it) radially, whilst in our head-man we are oriented spherically. If it were then a fundamental feature of our own state of movement that we relate ourselves differently to the Radius and to the encompassing Sphere, this fact would somehow make itself felt in what appears to us in the outer Universe.

Imagine what I have said to be in some way true. Suppose for instance that you yourself were moving thus (Fig. 8), — you were describing a Lemniscate. Let us assume however that the Lemniscate you were describing was not exactly like this, but that by variation of the constants the form of Lemniscate were brought about in which the lower branch did not close (Fig. 9). Assume then that a Lemniscate arises which by a certain variation of the constants is open on one side. The curve is mathematically feasible, and if you find the right way, you can certainly draw it into the human form and figure.

Figure 8 Figure 9

Say now that this were the surface of the Earth (Fig. 10). We should have to draw, somehow in relation to the Earth, what passes through our limb-nature and then in some way turns, goes through our head-nature and then back again into the Earth. Say you could truly draw into the nature and organisation of man such an open Lemniscate; we should be justified in saying: There is an open Lemniscate of this kind in man's nature. The question is, is it of real significance to speak of such an open Lemniscate in human nature? It is indeed. You need only make a deeper morphological study; you will find the Lemniscate, either in this or in some modified form, in diverse ways inscribed in human nature. These things have not been gone into with due method. I advise you, try it. (As I said,

we are only giving indications for further work; diligent research is needed.) Try it; investigate the curve that arises if you trace the middle line of a left-hand rib, then go past the junction into the vertebra, then turn and go back along the right rib (Fig. 11). Bear in mind what it must signify that as you go along this line — rib-vertebra-rib — various inner relationships of growth must play their part, not only quantitatively but qualitatively; then you will find in the Lemniscate with its loop-formation a morphological key to the whole system. Going upward from thence to the head-organisation, the farther you go upward, the more will you find it necessary to modify the form of Lemniscate. At a certain point you must imagine it transformed; the transformation is already indicated in the forming of the sternum, where the two come together. When you get up into the head there is a far-reaching metamorphosis of the lemniscatory principle. Study the whole human figure — the contrast above all of the nerves-and-senses organisation and the metabolic, — you get a Lemniscate tending to open out as you go downward and to close as you go upward. You also get Lemniscates — though highly modified, with the one loop extremely small — if you follow up the pathway of the centripetal nerves, through the nerve-centre and outward again to the termination of the centrifugal nerve. Follow it all in the right way: Again and again you will find this Lemniscate inscribed in man's nature, — man's above all. Then take the animal organisation with its manifestly horizontal spine. You will find it differing from the human, in that the Lemniscates, whether the downward loop be open or closed to some extent, are far less modified, less varied than they are in man. Moreover in the animal their planes are more parallel, whereas in man they are variedly inclined and askew to one another.

Figure 10

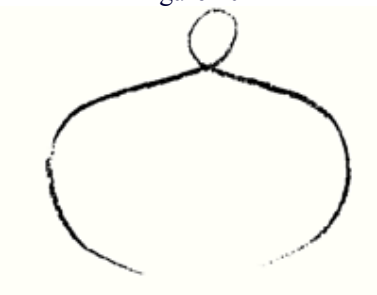

Figure 11

It is an immense and very promising field of work, — this ever-deepening elaboration of morphological study. And as you apprehend these tasks, you will appreciate the outlook of such men — of whom there have always been a few — as Moritz Benedikt for instance, whom I have mentioned before. Benedikt had many fruitful thoughts and good ideas. As you may read in his memoirs, he regretted how little possibility there is of speaking to doctors of medicine from a mathematical standpoint or with the help of mathematical notions. In principle he is quite right, only we have to go still farther. Ordinary mathematics, reckoning in the main on rigid forms of curve in a rigid Euclidean space, would help us little if we tried applying it to organic forms. Only by seeking, as it were, to carry life itself into the realms of mathematics and geometry as such, by thinking of the independent and the dependent variable in an equation as being subject to an organic and inherent variation, as illustrated yesterday for the Cassini curves (Variability of the first and of the second order), only thus shall we make progress. But if you do this immense possibilities will be opened up. It is indeed already indicated in the principles applied when constructing cardioid or cycloid curves; you must only not fall back again into rigidity of treatment.

Apply this principle — the inner mobility, as it were, of movement in itself — to Nature. Try to express in equations, this that 'moves the moving'. You will then find it possible, mathematically to penetrate what is organic. You will come to say, for it can well be formulated thus: The axioms of rigid space — space immobile in itself — lead to an understanding of inorganic Nature. Conceive a space that is inherently mobile — or algebraic equations whose very functionality is in itself a function — and you will find the transition to a mathematical understanding of organic Nature. This incidentally is the method which should accompany the efforts now being made to investigate the transition-forms from inorganic Nature to organic, as regards shape and form at least. Valueless apart from this, they have a future if this method be applied.

Take now the presence of the loop-making tendency in the human body and compare it with what confronts us, admittedly in a more irrational form, in the forms of movement of the planets. You will then realise: The 'apparent movements' of the planets, as we are wont to call them, in a most striking way inscribe, in forms of Movement in the Heavens, what in the human body is a Form as such — a characteristic, fundamental figure. Therefore, to say the least, we must in some way correlate this basic form in the human body and these phenomena in the Heavens. And we shall now be able to say: Behold the loop. It always appears when the planet is relatively near the Earth, — therefore when we, being on the Earth, are in a special relation to the planet. Consider the position of the Earth in its yearly course and our position on the Earth. (We must refer it back to our own formative period, the embryo-period of our life, needless to say.) Consider in effect how we are alternating between a position relative to the planet wherein we turn our head towards the planetary loop and a position where we take leave of the loop and at length turn our head away from it. We in our process of formation are thus related to the planet: We are exposed at one time to the planet's loop and at another to the remainder of its path. We can therefore relate, what lies nearer to our head, to the loop, and what belongs more to the remainder of our body, to the planetary path outside the loop.

Take in addition what I said before, I said, with regard to the morphological relation of the tubular or long bone to the skull-bone: Try how you would have to draw it. Here, throughout the long bone, is the radius; then as you pass to the skull-bone you will have to turn, like this (Fig. 12). Project this turn, in relation also to the Earth's movement, outward into the Heavens. It is the loop and the rest of the planet's path! If we develop a feeling for morphology in the higher sense, we can do no other than assign the human form and figure to the planetary system.

Fig. 12

And now the movement of the fixed stars themselves: — The movements of the fixed stars will naturally be less concerned with the several movements of individual human beings. Think on the other hand of the whole evolution of mankind on Earth. Bear in mind all we have said in these days of the relation of the great Sphere to the human head-formation. You cannot but divine that there will be some relation between the metamorphoses of aspect of the starry Heavens, and of the evolution of mankind in soul and spirit. There is the vault of the great Sphere above us. It reveals only that part of the movements which would correspond to the loop among the planets (nay more, as it would seem, only to part of the loop; Fig. 13, dotted line). In the movements of fixed stars, the rest of the path is omitted. Our attention is drawn to this great differentiation: The planets must somehow correspond to the whole man; the fixed stars only to what forms the head of man. Now we begin to get some guidance, how to interpret the loop.

Fig. 13

We human beings are in some way with the Earth. We are at some point on Earth and we move with it. We cannot but refer, what appears to us in projection on the vault of heaven, to the movements we ourselves are making with the Earth. For, as we move with the Earth (we ,must project this backward, once more, backward in time to the embryo-period of our life), — as we move with the Earth, what we have in us comes into being, formed as indeed it is by the very forces of movement. In the movements we see up yonder in their seeming forms and pictures, we have to recognise the cosmic movements we ourselves are making in the year's course. We realise it as we approach the true aspect of the loop-curve. (Downward of course we always see the loop still open. In the immediate aspect, it does not close at all. Looking at this alone, we should never get a complete path. We only get the complete path when contemplating the entire revolution.)

I am relating all this rather quickly. You must reflect on it in detail and try to see the different things together. The more minutely and scrupulously you do so, the more will you find that the planetary movements are, to begin with, images — images of — movements you yourself accomplish, with the Earth, in the year's course. (We shall see in time, how a synthesis arises from the different planetary movements.)

If then we see the human being as a whole and his projection to the Cosmos, we are led to recognise that the true form of movement of the Earth in the year's course will be the loop-curve or Lemniscate. We shall have to study it more closely during the next few days, but at this stage we are already led to conceive the path of the Earth itself as a loop-curve — quite apart now from its relation to the Sun or any other factor. What is projected then, for our perception, the planetary paths with the loops they make, — we must regard as the projection by the planets of the loop-path of the Earth on to the vault of Heaven, if we may formulate thus simply a very complicated set of facts. As to why, when the planet draws near the loop, we have to leave the rest of the path open during a relatively short space of time, — the reason lies in the fact that under certain conditions the projection of a closed curve may appear open. For example, if you were to make a Lemniscate, say of a flexible rod, and project the shadow of it on to a plane, you could easily make it so that the projection of the lower part appeared divergent and unclosed, whilst the upper part alone was closed; so the entire projection would become not unlike a planetary path. Quite simply in the shadow-figure, you could construct the likeness of a planet's path.

Notes:

1. In Figures 4 to 7 only one of the many varieties of loop which actually occur is shown in each case.

Lecture XII
Stuttgart, January 12, 1921

My Dear Friends,

I will begin today by pointing out that our studies hitherto have led us to a specific result. We have drawn attention on the one hand to the movements of the heavenly bodies, and, though it still remains for us to do it in more detail, we have at least gained some conception: Here are a number of cosmic bodies in movement, in a certain order and configuration. Meanwhile we have also been drawing attention to the form of man, and incidentally, from time to time, to the forms of animal and plant-nature; this we shall have to do still more, to gain the necessary supports from diverse realms. In the main however, it is the human form and figure we have contemplated, and in so doing we have divined that the formation of man is in some way related to what finds expression in the movement of celestial bodies. We want to formulate it with great care.

Yesterday I showed that wheresoever we may look in the human body, we shall find the formative principle of the looped curve or Lemniscate, save for the two outermost polarities — the Radius and the Sphere. Thus in the human body we perceive three formative principles (Fig. 1): The Sphere, with its activity primarily going inward, the Radius, and between these the looped curve or Lemniscate. Truly to recognise these formative principles in the human organism, you must imagine the Lemniscate as such with variable constants, if I may use the paradox. Where a curve normally has constants in its equation, we must think variables. The variability is most in evidence in the middle portion of the human body. Take as a whole the structure of the pairs of ribs and the adjoining vertebrae. True as it is then that in the vertebra the one half of the Lemniscate is very much condensed and pressed together, whilst in the pair of ribs the other half is much extended and drawn apart (Fig. 2), we must not be put off my this. The underlying formative principle is the Lemniscate, none the less. We simply have to imagine that where the ribs are (the drawing indicated those that are joined in front via the sternum) the space is widened, matter being as it were extenuated, while, to make up for this, the matter is compressed and the space lessoned in the vertebra.

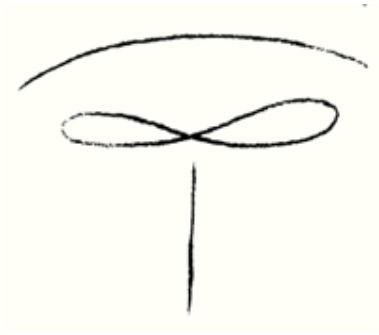

Figure 1

Let us now follow the human form and figure upward and downward from this middle portion. Upward we find the vertebra as it were bulged out into a wide cavity (Fig. 3), while the remaining branches of the Lemniscate seem to vanish, nestling away, so to speak, in the internal formative process, becoming hidden and undefined. Going downward from the middle portion, we contemplate for instance the attachment of the lower limbs to the pelvis. In all that opens downward from this point, we find the other half of the loop fading away. We have therefore to contemplate a fundamental loop-curve, mobile and variable in itself. This dominates the middle part of man. Only, the formative forces of it must be so imagined that in the one half (Fig. 2) the material forces become, as it were, more attenuated and the loop widens, while in the other it contracts.

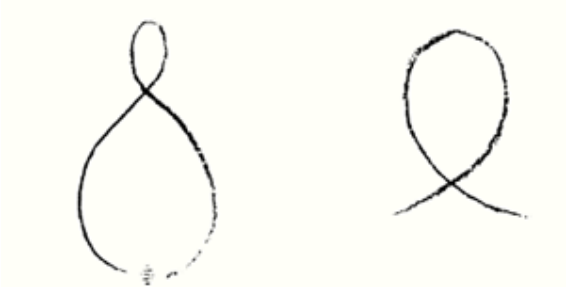

Figure 2 Figure 3

Further we must imagine that from this middle region upward the portion of the Lemniscate which in the vertebra was drawn together, bulges and widens out, while the other, downward-opening portion vanishes and eludes us. On the other hand, as you go downward from the middle part of man, the closed loop grows minute and fades away, while those portions of the curve which disappear as you go towards the head, run out into the radial principle and are here prolonged. (Fig. 4)

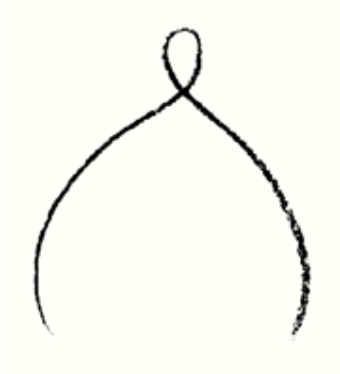

Figure 4

We should thus find our way into it, till we are able to see the only moving Lemniscate with perceptive insight. Also we think how the formative principle of the moving Lemniscate is combined with forces which are spheroidal on the one hand and on the other radial — radial with respect to the Earth's centre. We then have a system of forces which we may conceive as being fundamental to the form and figure, to the whole forming and configuration of the human body. (By the word “forces” I mean nothing hypothetical; — purely and simply what is made manifest in the forming of it.) Answering to this , in cosmic space, in the movement of celestial bodies, we also find a peculiar configuration, — configuration of movements. In yesterday's lecture, we recognised in the planetary loops the very same principle outside us which is the principle of form within us. Let us now follow this loop-forming principle in greater detail. Is it not interesting that Mercury and Venus make their loops when the planets are in inferior conjunction, i.e., when they are roughly between the Earth and the Sun? In other words, their loop occurs when what the Sun is for man — so to express it — is enhanced by Venus and Mercury. As against this, look for the loops of Mars, Jupiter and Saturn. These loops we find occurring when the planets are in opposition to the Sun. This contrast too, of oppositions and conjunctions, will in some way correspond to a contrast in the building forces of man. For Saturn, Jupiter and Mars, because their loops appear in opposition, the loops as loops will be most active and influential. Thinking along these lines, we shall indeed relate the loop-formation of Saturn, Jupiter and Mars to that in man which is little influenced by the Sun; for it takes place, once more, when the planet is in opposition. Whilst, inasmuch as Venus and Mercury form their loops when in conjunction, their loop-formation must in some way be related to what is brought about, amid the formative principles of man, by the Sun — or by what underlies the Sun. We shall therefore conceive the Sun's influence to be in some sense reinforced by Venus and Mercury, while it withdraws, as it were, in face of the superior planets, so-called. The latter, precisely during loop-formation, bring to expression something that bears directly, not indirectly, upon man.

If we pursue this line of thought and bear in mind that there is the contrast between Radius and Sphere, then we need but recall the form that comes to manifestation in these movements, and we shall say: In Mays, Jupiter and Saturn the essential phase must be when they are forming their loops, that is to say, when, in a manner speaking, the sphere-forming process comes into evidence. Mars, Jupiter and Saturn (not to speak of further planets) will show their influence upon that element in man which is assigned to the sphere-forming process, namely the human head. In contrast to this — they are indeed the polar opposite — the movements of Venus and Mercury will somehow find expression in what in man too is the opposite pole, opposite to the forming of the head, — i.e., what abandons parallelism with the spherical formation and becomes parallel to the radial. Where the one part of the Lemniscate becomes minute and the other grows into the limbs, into a purely radial development, we have to look for the relation to Venus and Mercury. This in turn will lead us on to say: In the superior planets, which make their loop when in opposition, it is the loop that matters; they develop their intensity while they form the loop. Whilst in the inferior planets Venus and Mercury — it is essential that they wield their influence by virtue of what is not the loop, — i.e., in contrast to the loop, by the remainder of the planet's path. Think of a Lemniscate like this (Fig. 5), say in the case of Venus (I draw it diagrammatically).

Figure 5

You will understand it if you imagine this part (dotted line) ever less in evidence, the farther you go downward. That is to say, whilst in the path of Venus it closes, in its effects it no longer does so, but, as it were, runs out into parabolic branches, answering precisely to what happens in the human limb, where the vertebra form fades away and loses character (to put it very briefly, omitting details). This loop of the Lemniscate is represented by the path's fading away, not being fully maintained; it only indicates the direction but cannot hold it. So, where it closes in the path of Venus in the Heavens, in man's formation it falls asunder. Thus, to sum up, the building principle of the human form, howsoever modified, is based on this; the metamorphosis emerges between head and limbs — the limbs with the metabolism which belongs to them — and in the great Universe this answers to the contrast between those planets that form them in opposition to the Sun. Between the two is then the Sun itself.

Now, my dear friends, something quite definite results from this Namely, we see that also with respect to the qualitative effects we have just referred to, we have to recognise in the Sun's path, even as to its form, something midway between what we find in the forms movement of the superior and of the inferior planets respectively. We must therefore assign, what finds expression in the path and movement of the Sun, to all that in man which is midway between the forming of the head and the metabolism, In other words, we must attribute to the rhythmic system some relation to the path of the Sun. We therefore have to imagine a certain contrast between the paths of the superior and of the inferior planets; and in the Sun's path a quality midway between the two.

There is now a very evident and significant fact, regarding both the Sun's path and the Moon's. Follow the movements of the two heavenly bodies; neither of them makes any loop. They have no

loop. Somehow therefore we must contrast the relation to man, and to Earth nature generally, of Sun and Moon on the one hand and of the loop-forming planetary paths on the other. The planetary paths with their characteristic loops quite evidently correspond to what makes vortices and vertebrae, — to what is lemniscatory in man.

Look simply at the human form and figure and think of its relation to the Earth; we can do no other than connect what is radial in human form and stature with the path of the Sun, even as we connect what is lemniscatory in form with the typical planetary path.

You see then what emerges when we are able to relate to the starry Heavens the entire human being, not only the human organ of cognition. This in effect emerges: In the vertical axis of man we must in some way seek what answers to the Sun's path, whilst in all that is lemniscatory in arrangement we have to seek what answers to the planetary paths, — lemniscatory as they are too, though in a variable form. Important truths will follow from this, We must conceive, once more, that through his vertical axis man is related to the Sun's path. HOW then shall we think of the other path which also shows no loops, namely the Moon's? Quite naturally — you need only look with open mind at the corresponding forms on Earth — we shall be led to the line of which we spoke some days ago, the line that runs along the spine of the animal. There we must seek what answers to the Moon's path. And in this very fact — the correspondence of the human spinal axis to the Sun's path and of the animal spinal axis to the moon's _ we shall have to look for the essential morphological difference between man and animal.

Precisely therefore when we are wanting to discover what is essential in the difference of man and animal, we cannot stay on Earth. A mere comparative morphology will not avail us, for we must first assign what we there find to the entire Universe. Hence too we shall derive some indication of what must be the relative position of the Sun's path and the Moon's — shall we say, what is their mutual situation, to begin with, in perspective (for here again we must express it with great caution). They must be so situated that the one path is approximately perpendicular to the other.

The human vertical therefore — or, had we better say, what answers to the main line and direction of the spine in man — is related to the Sun's path. The rational morphology we are pursuing makes this coordination evident. Mindful of this, we must surely relate the Sun's path itself to what in some way coincides with the Earth's radius. Admittedly, the Earth may move in such a way that many of her radii in turn coincide with the Sun's path. The relation indicated will need defining more precisely in coming lectures. Yet this at least gives us a notion of it: the direction of the Sun's path must be radial in relation to the surface or the Earth. We have no other alternative. In no event can the Earth be revolving round the Sun. What has been calculated — quite properly and conscientiously, of course — to be the revolution of the Earth around the Sun must therefore be a resultant of some other kind of movements. To this conclusion we are driven.

The many relevant details as regards human form and growth are so very complicated that in this brief lecture-course not everything can be gone into. But if you really concentrate upon the morphological descriptions given (though they are only bare indications of a qualitative morphology), you will be able to read it in the human form itself: The Earth is following the Sun! The Sun speeds on ahead, the Earth comes after. This then must be the essence of the matter: the earthly and the solar orbit in some way coincide, and the Earth somehow follows the Sun, making it possible as the Earth rotates for the Earth's radii to fall into the solar path, or at the very least to be in a certain relation to it.

Now you may very naturally retort that all this is inconsistent with the accepted Astronomy. But it is not so, — it really isn't! As you are well aware, to explain all the phenomena, Astronomy today must have recourse not only to the primary notion of a stationary Sun supposed to be at the focus of an ellipse along which the Earth is moving — but to a further movement, a movement of the Sun itself towards a certain constellation. If you imagine the direction of this movement and other relevant factors, then from the several movements of Sun and Earth, you may well be able to deduce a resultant path for the Earth, no longer coincident with the ellipse in which the Earth is said to be going round

the Sun, but of a different form which need not be at all like the supposed ellipse. All these things I am gradually leading up to; for the moment I only wish to point out that you need not think what I am telling you so very revolutionary as against orthodox Astronomy. Far more important is the method of our study, — to bring the human form and figure into the system of the starry movements. My purpose here is not to propound some astronomical revolution, nor is it called for. Look, for example: say this or something like it (Fig. 6) is the Earth's movement, and the Sun too is moving, You can well imagine, if the Earth is following the Sun in movement, it is not absolutely necessary for the Earth always to be running past the Sun tangentially. It may well be that the Sun has already gone along the same path and that the Earth always to be running past the Sun tangentially. It may well be that the Sun has already gone along the same path and that the Earth is following, Nay, it is possible, envisaging the hypothetical velocity that has been calculated for the Sun's proper movement, you may work out a very neat arithmetical result. Work out the resultant of the assumed Earth-movement and the assumed Sun-movement; you may well get a resultant movement compatible with present-day Astronomy, — velocity and all. Let me then emphasise once more: What I am here propounding is not unrelated to present-day Astronomy, nor do I mean it not be. Quite on the contrary, it is related to it more thoroughly and deeply than theories which are so frequently presented, nicely worked out in theoretic garb, selecting certain movements and omitting others. I am not therefore instigating an astronomical revolution in these lectures; let me say this again to prevent fairy-tales arising. What I intend is to co-ordinate the human form — inward and outward form, figure and formation — with the movements of the heavenly bodies, nay, with the very system of the Cosmos.

Figure 6

For the rest, may I call your attention to this: It is not so simple to bring together in thought our astronomical observations of the heavenly bodies and the accepted constructions of the orbits. For as you know from Kepler's Second Law, an essential feature, on which the forms of the orbits depend, are the radius-vectors, — their velocity above all. The whole form of the path depends on the functionality of the radius vectors. If this be so, does it not also reflect upon the forms of the paths which actually confront us? May it not be that we are cherishing illusions after all, at the mere outward aspect of them? It is quite possible: What we here calculate from the velocity and length of the radius vectors might not be primary magnitudes at all. They might themselves be only the resultants of the true primary magnitudes. If so, then the seeming picture which emerges must refer back to another and more deeply hidden.

This too is not so far afield as you might think. Suppose that in the sense of present-day Astronomy you wished to calculate the Sun's exact position at a given time of day and on a given date. Then it will not suffice you to take your start from the simple proposition, 'the Earth moves round the Sun'. People have thought it strange that in the ancient Astronomy (that of the Mysteries, not the exoteric version) they spoke of three Suns instead of one. So they distinguished three Suns. I must confess, I do not find it so very striking. Modern Astronomy too has its three Suns. There is the Sun whose path is calculated as the apparent counterpart of the Earth's movement round the Sun. This Sun occurs, does it not , in modern Astronomy? The path of it is calculated. Astronomy then has another Sun — an imagined one of course — with the help of which certain discrepancies are corrected. And then it has a third Sun, with the help of which it re-corrects discrepancies that persist after the first correction. Modern Astronomy too therefore distinguishes three: the real Sun and two imagined ones. It needs the three, for what is calculated to begin with does not accord with the Sun's actual position. It is always necessary to apply corrections. This alone should be enough to show you that we should not build too

confidently on mere calculation. Other means are needed to arrive at adequate conceptions of the starry movements; others than the science of our time derives from sundry premises of calculation.

The broad ideas of planetary paths we have been laying out, it I may put it so, call now for great definition. Yet we shall only come to this if we contrive first to go further in out study of Earth-nature, to see their mutual relation in a certain aspect.

The Kingdoms of Nature are commonly thought of in a straight line: mineral kingdom, plant kingdom, animal kingdom, and I will add, human kingdom. (Some authorities would not admit the fourth, but that need not detain us.) The question now is: Is this arrangement sensible at all? Undoubtedly it is implicit in many of our modern lines of thought; at least it was so in the golden age of the mechanical outlook upon Nature. Today I know, in these wider realms of Science, there is a certain atmosphere of resignation, not to say despair. The habits of mind however remain the same as at their heyday, 20 or 30 years since. The scientists of that time would have been content, had they been able to follow up this series — mineral kingdom, plant kingdom, animal kingdom, man, — with the mineral kingdom as the amplest, deriving therefrom, by some combination of mineral structure, the structure of the plant, then by a further combination of plant structure the structure of the animal, and so on to man. The many thoughts that were pursued about the primal generation of living things, generatic aequivocs, — were they not eloquent of the tendency to derive animate living Nature from inanimate and at long last from inorganic or mineral? To this day, I believe, many scientiste would doubt if there is any other rational way of conceiving the inner connection in the succession of Nature's Kingdoms than by deriving them all ultimately from the Inorganic, even where they culminate in Man. You will find countless papers, books, lectures and so on, including highly specialised ones claiming to be strictly scientific, the authors of which — as though hypnotised — are always looking at it from this angle. How, they inquire, can it have happened, somewhere at some time in the course of Nature, that the first living creature came into being from some molecular distribution, i.e. from something purely mineral in the last resort?

The question now is, is it true at all to put the kingdoms of Nature in series in this way? Can it be done? Or, if we do, are we doing justice to their most evident and essential features? Compare a creature of the plant kingdom with an animal to begin with. Taking together all that you observe, you will not find in the forming of the animal anything that looks like a mere continuation or further elaboration of what is vegetable. If you begin with the simplest plant, the annual, you may well conceive its formative process to be carried further in the perennial. But you will certainly not be able to detect, in the organic principles of plant form and growth, anything that suggests further development towards the animal. On the contrary, you will more likely ascertain a polarity, a contrast between the two. You apprehend this polarity in the most evident phenomenon, namely the contrasting processes of assimilation: the altogether different relation of the plant and of the animal to carbon, and the characteristic use that is made of oxygen. I may remark, you must be careful here, to see and to describe it truly. You cannot simply say, the animal breathes-in oxygen while the plant breathes oxygen out and carbon in. It is not so simple as that. Nevertheless, the plant-forming process taken as a whole, in the organic life, reveals an evident polarity and contrast (as against the animal) in its relation to oxygen and carbon. The easiest way to put it is perhaps to say: What happens in the animal, in that the oxygen becomes bound to carbon and the carbonic acid is expelled, is for the animal itself and for man too. — an un-formative process, the very opposite of formative, a process which must be eliminated if the animal is to survive. And now the very thing which is undone in the animal, has to be done, has to be formed and builded in the plant. Think of what in the animal appears in some sense as a process of excretion, what the animal must get rid of makes for the forming and building process in the plant. It is a tangible polarity. You cannot possibly imagine the plant-forming process prolonged in a straight line, so as to derive therefrom the animal-formation. But you can well derive from the plant-forming process what has to be prevented in the animal. From the animal the carbon has to be taken away by the oxygen in the carbonic acid. Turn it precisely the other way round, and you will readily conceive the plant-forming process.

You therefore cannot get from plant to animal by going on in a straight line. On the other hand you can without false symbolism imagine here an ideal mean or middlepoint, on the one side of which you see the plant — and on the other the animal — forming process. It forks out from here (Fig. 7). What is midway between, — let us imagine it as some kind of ideal mean. If we now carry the plant forming process further in a straight line we arrive not at the animal but at the perennial plant. Imagine now the typical perennial. Carry the stream of development which leads to it still further; in some respects at least you will not fail to recognise in it the way that leads toward mineralisation. Here then you have the way to mineralisation, and we may justly say; In direct continuation of the plant forming process there lies the way that leads to mineralisation. Now look what answers to it at the contrasting pole, along the other branch (Fig. 7). To proceed by a mere outward scheme, one would be tempted to say: this branch too must be prolonged. There would be no true polarity in that. Rather should you think as follows: In the plant-forming process I prolong the line. In the animal-forming process I shall have to proceed negatively, I must go back, I must turn round; I must imagine the animal-forming process not to shoot out beyond itself but to remain behind — behind what it would otherwise become.

Figure 7

Observe now what is already available in scientific Zoology, in Selenka's researches for instance on the difference between man and animal in the forming of the embryo and in further development after birth, — comparing man and the higher animals. You will then have a more concrete idea of this "remaining behind". Indeed we owe our human form to the fact that in embryo-life we do not go as far as the animal but remain behind. Thus if we study the three kingdoms quite outwardly as they reveal themselves, without bringing in hypotheses, we find ourselves obliged to draw a strange mathematical line, that tends to vanish as we prolong it. This is what happens at the transition from animal to men, whilst on the other side we have a line that really lengthens (Fig. 8).

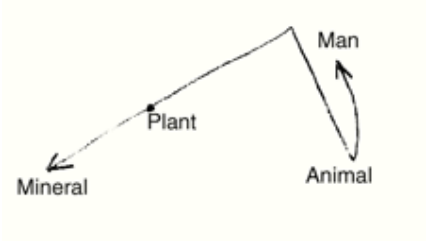

Figure 8

Here is a fresh extension of mathematics. You are led to recognise a distinction — a purely mathematical one — when you draw this diagram. Namely there are lines which when continued grow longer, and there are lines which when continued grow shorter. It is a fully valid mathematical idea. If then we want to set out the Kingdoms of Nature in a diagram at all, we must do it thus. First we must have some ideal point to start from. Thence it forks out: plant kingdom, animal kingdom on either hand. Thereafter we must prolong the two lines. Only, the plant-kingdom-line must be so prolonged that it grows longer; the animal-kingdom-line so that it grows shorter as we prolong it. I say again, this is a genuine , mathematical idea.

We thus arrive at real relationships between the Kingdom of Nature, though we begin by simply placing them side by side. The question now is — and we will only put it as a question, — What in reality corresponds to the ideal point in our diagram? We may divine that as the forming of the

Kingdoms of Nature is related to this ideal point, so too must there be movements in the great Universe which relate to something somehow corresponding to it, — to this ideal mean. Let us reflect on it until tomorrow.

Lecture XIII
Stuttgart, January 13, 1921

My Dear Friends,

In popular works, as you are well aware, the evolution of astronomical ideas is thus presented — Until Copernicus, they say the Ptolemaic system was prevailing. Then through the work of Copernicus the system we accept — though with modifications — to this day, became the intellectual property of the civilised world. Now for the thoughts we shall pursue in the next few days it will be most important for us to be aware of a certain fact in this connection. I will present it simply by reading, to begin with, a passage from Archimedes. Archimedes describes the cosmic system or starry system as conceived by Aristarchus of Samos, in these words — "In Aristarchus' opinion the Universe is far, far greater. He takes the stars and the Sun to be immobile, with the Earth moving around the Sun as centre. He then assumes that the sphere of the fixed stars, — its centre likewise in the Sun, — is so immense that the circumference of the circle, described by the Earth in her movement, is to the distance of the fixed stars as is the centre of a sphere to the surface thereof."

Taking these words to be a true description of the spatial World-conception of Aristarchus of Samos, you will admit: Between his spatial picture of the Universe and ours, developed since the time of Copernicus, there is no difference at all. Aristarchus lived in the third Century before the Christian era. We must therefore assume that among those who like Aristarchus himself were leaders of cultural and spiritual life in a certain region at that time, fundamentally the same spatial conception of the World held good as in the Astronomy of today. Is it not all the more remarkable that in the prevailing consciousness of men who pondered on such things at all, this work-conception — heliocentric, as we may call it, — thereafter vanished and was supplanted by that of Ptolemy? Till, with the rise of the new epoch in civilisation, known to us as the Fifth post-Atlantean, the heliocentric idea comes forth again, which we have found prevailing among such men as Aristarchus in the 3rd Century B.C.! (For you will readily believe that what held good for Aristarchus, held good for many people of this time.) Moreover if you are able to study the evolution of mankind's spiritual outlook — though it is difficult to prove by outer documents — you will find this heliocentric conception of the World the more widely recognised by those who counted in such matters, the farther you go back from Aristarchus into more distant times. Go back into the Epoch we are wont to call the Third post-Atlantean, and it is true to say that among those who were the recognised authorities the heliocentric conception prevailed during the Epoch. The same conception prevailed which Plutarch says was held by Aristarchus of Samos. Plutarch moreover described in such terms that we can scarcely distinguish it from that of our own time.

This is the noteworthy fact. The heliocentric conception of the World is there in human thought, the Ptolemaic system supplants it, and in the Fifth post-Atlantean Epoch it is re-conquered. In all essentials we may aver that the Ptolemaic system held good for the Fourth post-Atlantean Epoch and for that alone. Not without reason do I bring this in today, after speaking yesterday of an 'ideal point' in the evolution of the Kingdoms of Nature. As we shall see in due course, there is an organic relationship between these diverse facts. But we must first enter more fully into the one adduced today.

What is the essence of the Ptolemaic cosmic system? The essence of it is that Ptolemy and his followers go back again to the idea of an Earth at rest, with the fixed-star Heavens moving around the Earth; likewise the Sun moving around the Earth. For the movement of the planets, the apparent forms of which we have been studying, he propounds peculiar mathematical formulae. In the main, he thinks in this way: Let this be the Earth (Fig. 1). Around it he conceives the Heaven of fixed stars. Then he imagines the Sun to be moving in an eccentric circle round the Earth. The planets also move in circles. But he does not imagine them to move like the Sun in one circle only. No; he assumes a point (Fig. 1) moving in this eccentric circle which he calls the 'Deferent', and he makes this point in its turn the centre of another circle. Upon this other circle he lets the planet move, so that the true path of the

planet's movement arises from the interplay of movements along the one circle and the other. Take Venus for example. Says Ptolemy: around this circle another circle is rotating; the centre of the latter circle moves along the former. The actual path of Venus would then be, as we should say, a resultant of the two movements. Such is the planet's movement around the Earth; to comprehend it we must assume the two circles, the large one, called the “deferent”, and the small one, know as the ‘epicyclic’ circle. Movements of this kind he attributes to Saturn, Jupiter, Mars, Venus an Mercury, only not to the Sun. The Moon he conceives to move in yet another small circle, — an epicyclic circle of its own.

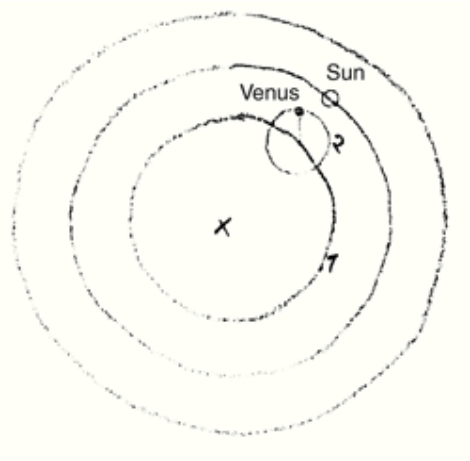

Figure 1

These assumptions were due to the Ptolemaic astronomers having calculated with great care the positions on the Heavens at which the planets were at given times. They computed these circling movements so as to understand the fact that the planets were at given places at given times. It is astonishing how accurate were the calculations of Ptolemy and his followers, — relatively speaking at least. Draw the path of any planet — Mars, for instance — from modern astronomical data. Compare this 'apparent path', so-called, of Mars, drawn as observed today, with the path derived from Ptolemy's theory of deferent and epicyclic circles. The two curves hardly differ. The difference, relatively trifling, is only due to the still more accurate results of modern observation. In point of accuracy these ancients were not far behind us. That they assumed this queer system of planetary movements, which seems to us so complicated, was not due therefore to any faulty observation. Of course the Copernican system is simpler, — that will occur to everyone. There is the Sun in the midst, with the planets moving n circles or ellipses round it. Simple, is it not? Whereas the other is very complicated: a circular path superimposed upon another circle, and an eccentric one to boot.

The Ptolemaic system was adhered to with a certain tenacity throughout the Fourth post-Atlantean epoch, and we should ask ourselves this question: Wherein lies the essential difference in the way of thinking about cosmic space and the contents of cosmic space, such as we find it in the Ptolemaic school on the one hand and in Aristarchus and those who thought like him in the other? What is the real difference between these ways of thinking about the cosmic system? It is difficult to describe popularly, for many things seem outwardly alike, whilst inwardly they can be very different. Reading Plutarch's description of Aristarchus system, we shall say: This heliocentric system is fundamentally no different from the Copernican. Yet if we enter more deeply into the spirit of the Aristarchian world-picture, we find it different. Aristarchus too, no doubt, follows the outer phenomena's with mathematical lines. In mathematical lines he represents to himself the movements of the heavenly bodies.

The Copernican's do likewise. Between the two there intervenes this other system — the strange one of the Ptolemaic school. Here it cannot be said that the forming of mathematical pictures coincides in the same way with what is observed. The difference in this respect is all-important. In the Ptolemaic school, the mathematical imagination does not directly rest upon the sequence of observed points in

space. It is rather like this: In order ultimately to do justice to them it goes right away from the observed phenomena and works quite differently, not merely putting the observed results together. Yet in the end it is found that if one does admit the mathematical thought-pictures of the Ptolemaic school, one thereby comprehends what is observed.

Suppose a man of today were to make a model of the planetary system. Somewhere he would attach the Sun, them he would draw wires to represent the orbits of the planets; he would really think of them as representing the true orbits. In purely mathematical lines he would comprise the logic of the planets' paths. Ptolemy would not have done so. He would have had to construct his model somewhat in this fashion (Fig. 2). Here would have been a pivot, fixed to it a rod, leading to the rim of a rotating wheel, upon this again another wheel rotating. Such would be Ptolemy's model. The model he makes, the mathematical picture living in his thought, is not in the least like what is outwardly seen. For Ptolemy the Mathematical picture is quite detached from what is seen externally. And now, in the Copernican system we return to the former method, simply uniting by mathematical lines the several places, empirically observed, of the planet. These mathematical lines correspond to what was there in Aristarchus's system. Yet is it really the same? This is the question we must now be asking: Is it the same?

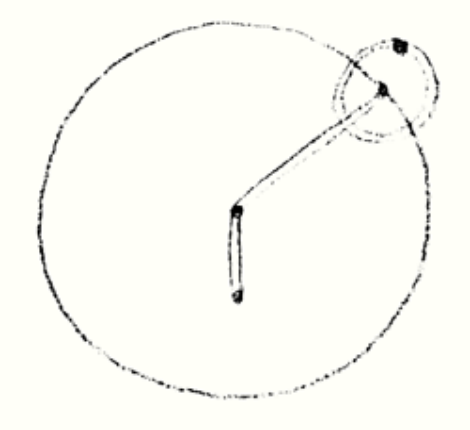

Figure 2

Bearing in mind the original premises of the Copernican system and the kind of reasoning by which it is maintained, I think you will admit: It is just like the way we relate ourselves, mathematically, to empirical reality in general. You may confirm it from his works. Copernicus began by constructing his planetary system ideally, much in the same way as we construct a triangle ideally and then find it realised in empirical reality outside us. He took his start from a kind of a priori mathematical reasoning and them applied it to the empirically given facts.

What then is at the bottom of this complicated Ptolemaic system, to make it so complicated? You remember the well-known anecdote. When it was shown to Alphonso of Spain, he from his consciousness of royalty declared: Had God asked his advice at the Creation of the World, he would have made it more simply than to require so many cycles and epicycles.

Or is there something in it after all — in this construction of cycles and epicycles — related to a real content of some kind? I put the question to you: Is it only fantasy, only a thing thought-out, or does this thought out system after all contain some indication that it relates to a reality? We can only decide the question by entering into it in greater detail.

It is like this. Suppose that with the Ptolemaic system taking you start from Ptolemaic theories — you follow the movements, or, as we should say, the apparent movements of the Sun, and of Mercury, Venus, Mars, Jupiter, and Saturn: to begin with you will have angular movements of a certain magnitude each time. You can therefore compare the movements indicated by the successive positions

of these heavenly bodies in the sky. The Sun has no epicyclic movement. The epicyclic daily movement of the Sun is therefore zero. For Mercury on the other hand we must put down a number, representing his daily movement along his epicyclic circle, which we shall them compare with that of other planets. Let us call the epicyclic daily movements —

x3 + x' = y

x4 + x ' ' = y

x5 + x' ' ' = y.

Now take the movements Ptolemy attributes to the centres of the epicycles along their different circles. Let the daily movement be y for the Sun. It is then remarkable that if we seek the corresponding value for Mercury we get precisely the same figure. The movement of the centre of Mercury's epicycle equals the movement of the Sun. We must write y again, and so for Venus. This then holds good of Mercury and Venus. The centres of their epicycles move along paths which correspond exactly to the Sun's path, — run paralleled to it. For Mars, Jupiter and Saturn on the other hand the movements of the centres of the epicycles are diverse, — shall we say

x for Mars,

x for Jupiter,

x for Saturn.

Yet the remarkable fact is that by taking the corresponding sums, namely x3 + x + x4 + x , x5 _ x, adding the movements along the several epicycles to the movements of the centres of these epicycles, — I get the same magnitude for all three planets. Nay more, it is the identical which we obtained just now for the movement of the Sun and of the centres of the epicycles of Mercury and Venus —

x3 + x = y,

x4 + x = y,

x5 + x = y.

A noteworthy regularity, you see. This regularity will lead us to attribute a different cosmic significance to the centres at the epicycles of Venus and Mercury, the planets near the Sun as they are called, and of Jupiter, Mars, Saturn etc. called distant from the Sun. For the distant planets, the centre of the epicycle has not the same cosmic meaning. Something is there, by virtue of which the whole meaning of the planet's course is different than for the planets near the Sun.

The fact was well-known in the Ptolemaic school and helped determine the whole idea — the peculiar construction of cycles and epicycles in the mind, detached from the empirically given facts. This very fact obliged them, as they saw it, to propound their system, and is implicit in it. The human being of today would scarcely recognise it there; he listens more or less obtusely when told how they set up their cycles and epicycles. To their way of thinking on the other hand the thought was palpable and eloquent???. If Mercury and Venus have the same values as Jupiter, Saturn and Mars, yet in another realm, we cannot treat the matter so simply, with an indifferent circling motion or the like. A planet, in effect, is of significance not only within the space it occupies but outside it. We have not merely to stare at it, fixing its place in the Heavens and in relation to other celestial bodies; we must go out of it to the centre of the epicycle. The centre of its epicycle behaves in space even as the Sun does. Once more, translated into modern forms of speech, the Ptolemaists said: For Mercury and Venus the centres of the epicycles so far as movement is concerned behave in cosmic space as the Sun itself behaves. Not so the other planets — Mars, Jupiter and Saturn. They claim another right. In

effect, only when we add their epicyclic movements to their movements along the deferent, only then do they grow like the Sun in movement. They therefore are differently related to the Sun.

This difference of behaviour in relation to the Sun was what they really built on in the Ptolemaic system. This among others was an essential reason for its development. Their aim was not merely to join the empirically given places in the Heavens by mathematical lines, building it all into a system of thought in this way. They were at pains to build a thought-system on another basis, and what is more, a piece of true knowledge under-lay their efforts; it is undeniable if we go into it historically. Modern man naturally says: We have advanced to the Copernican system, why bother about these ancient thinkers? He bothers not, but if he did, he would perceive that this was what the Ptolemaists meant. 'Truth is', they said to themselves, Mars, Jupiter and Saturn have quite another relation to Man than Mercury and Venus. What corresponds to them in Man is different. Moreover they connected Jupiter, Saturn and Mars with the forming of the human head, Venus and Mercury with the forming of what is beneath the heart in man. Rather than speak of the head, perhaps I should put it in these words: they related Jupiter, Saturn and Mars with the forming of all that is above the heart; Venus and Mercury with what is situated below the heart in man. The Ptolemaists did indeed relate to man, what they were trying to express in their cosmic system.

What under-lay it really? To gain true judgement on this question, my dear Friends, I think you should read and mark the inmost tone and essence of my Riddles of Philosophy, in writing which I tried to show how very different was the way man met the world in his life or knowledge before the 15th Century and after. Since then, if I may use this image we unpeel ourselves from the world, — we detach ourselves completely. Before the 15th Century we did not do so. I must admit, at this point it is difficult to make oneself understood in the modern world. Man of to-day says to himself: “I think thus and thus about the world. I have my sense perceptions, thus or thus. In modern times we have become enlightened; the men of former times were simple, with many childish theories.” And as to our enlightenment and their simplicity the modern man's idea of it amounts to this, or something very like it: "If only the coons had tried hard enough, they might have grown just as clever as we are. But it took time, this eduction of mankind; it evidently had to take some time for men to get as enlightened as they afterwards became.”

What is today left unconsidered, is that man's very seeing of the world, his seeing and his contemplating, his whole relation to the world was different. Compare the different stages of it, described in my Riddles of Philosophy. Then you will say: Through the whole time from the beginning of the Fourth Epoch until the end, the sharp distinction we now have, of concept and idea on the one hand and sense-perceived data on the other, did not exist. They coincided rather. In and with the sensory quality, men saw the quality of thought, the idea. And it was ever more so, the farther we go back in them. In this respect we need more real notions as to the evolution of mankind. What Dr. Stein has written for example in his book, upon the essence of sense-perception, is true of our time and excellently stated. I he had had to write a dissertation on this subject in the School of Alexandria in olden time, he would have had to write very differently of sense-perception. This is what people of today persist in disregarding; they will have everything made absolute.

And if we go still farther back, for example into the time when the Egypto-Chaldean Epoch was at its height, we find an even more intensive union of concept and idea with sense-perceptible, outward and physical reality. It was from this moreover — from this more intensive union — that the conceptions arose which we still find in Aristarchus of Samos. They were already decadent in his time; they had been entertained even more vividly by his predecessors. The heliocentric system was simply felt, when with their thoughts and mental pictures men lived in and with the outer sense-perceptible reality. Then, in the Fourth post-Atlantean Epoch, man had to get outside the sense-world; he had to wean himself of this union of his inner life with the sense-world. In what field was it easiest to do so? Obviously, in the field where it would seem most difficult to bring the outer reality and the idea in the mind together. Here was man's opportunity to wrest himself away — in his life of ideas — from sense-impressions.

Look at the Ptolemaic system from this angle; see in it an important means toward the education of mankind; then only do we recognise the essence of it. The Ptolemaic system is the great school of emancipation of human thoughts from sense-perception. When this emancipation had gone far enough when a certain degree of the purely inner capacity of thought had been attained — then came Copernicus. A little later, I may add, this attainment became even more evident, namely in Galileo and others, whose mathematical thinking is in the highest degree abstracted and complicated. Copernicus presented to himself the facts of which we have been speaking — the observation of the equality of y at diverse points in the equation, and, working backward from these mathematical results, was able to construct his cosmic system. For the Copernican system is based on these results. It represents a return, from the ideas now abstractly conceived, to the external, physically sense-perceptible reality.

It is most interesting to witness, how in the astronomical world-picture above all, mankind gets free of the outer reality. And in perceiving this, my dear Friends, we also gain a truer estimate of the returning pathway, — for in a wider sense we must return. Yet how? Kepler still had a feeling of it. I have often quoted his rather melodramatic saying, to the effect: I have stolen the sacred vessels of the Egyptian Temples to bring them back again to modern man. Kepler's planetary system, as you know, grew from a highly romantic conception of how the Universe is built. In deed he feels it like a renewal of the ancient heliocentric system. Yet the truth is, the ancient heliocentric system was derived, not from a mere looking outward with the eyes, but from an inner awareness, an inner feeling of what was living in the stars.

The human being who originally set up the cosmic system, making the Sun the centre with the Earth circling round it after the manner of Aristarchus of Samos, felt in his heart the influences of the Sun, felt in his head the influences of Venus and Mercury. This was experience, direct experience throughout the human being, and out of this the system grew. In later time this all-embracing experience was lost. Perceiving still with eyes and ears and nose, man could no longer perceive with heart or liver. To have perception from the Sun with one's heart, or from Jupiter with one's nose, seems like sheer madness to the people of today. Yet it is possible and it is exact and true. Moreover one is well aware why they think it madness.

This living with the Universe, intensively and all-awarely, was lost in course of time. Then Ptolemy conceived a mathematical world-picture still with a little of the old feeling to begin with, yet in its essence already detached from the world. The earlier disciples of the Ptolemaic school still felt, though very slightly, that it is somehow different with the Sun than with Jupiter for instance. Later they felt it no more. In effect the Sun reveals his influence comparatively simply through the heart. Jupiter, we must admit, spins like a wheel in our head, — it is the whirling epicycle. Whilst in a different sense, here indicated (Fig. 1), Venus goes through beneath our heart. In later Ptolemaic times, all they retained of this was the mathematical aspect, the figure of the circle: the simple circle for the Sun's path and the more complicated for the planets. Yet in this mathematical configuration there was at least some remnant of relation to the human being.

Then even this was lost and the high tide of abstraction came. Today we must look for the way back, — to re-establish once again from the entire Man an inner relation to the Cosmos. We have not to go on from Kepler, as Newton did, into still further abstractions. For Newton put abstractions in the place of things more real; he introduced mass etc. into the equations — a mere transformation, in effect, yet there is no empirical fact to vouch for it. We need to take the other road, whereby we enter reality even more deeply then Kepler did. And to this end we must include in our ambit what after all is in its life connected with the rising of the stars across the Heavens, namely the Kingdoms of external Nature in all their variedness of form and kind.

Is it not worthy of note that we find a contrast between the superior planets so-called and the inferior, with the Earth-entity between the mineral and plant kingdoms along the one branch, the animal and man along the other? And, that in drawing the two branches of the forked line, we must put plant and mineral in simple prolongation, while animal and man must be so drawn as to show the formative process returning upon itself? (Fig. 3)

Figure 3

We have put two things and of different kind before us: on the one hand the paths of the epicycle-centres and of the points on the epicyclic circumference, revealing a quite different relation to the Sun for the superior and inferior planets respectively; on the other hand the prolongation of the plant-forming process speeding on into the mineral, whilst the animal-forming process turns back upon itself to become man. (The symbolism of our diagram is justified; as I said yesterday, to recognise it you need only make a study of Selenka's work.)

These two things side by side we put as problems, and we will try from thence to reach a cosmic system true to reality.

Lecture XIV
Stuttgart, January 14, 1921

My Dear Friends,

Today we will develop the different notes we touched on, — the notes which we were striking yesterday. From the material at our disposal, consisting as it does in the last resort of things observed, the true aspect of which we seek to divine, — from this observed material we shall try to gain ideas, to lead us into the inner structure of the celestial phenomena. I will first point to something that will naturally follow on the more historical reflections of yesterday.

We realise that in the last resort both the Ptolemaic system and that used by modern Astronomy are attempts to synthesise in one way or another, what is observed. The Ptolemaic system and the Copernican are attempts to put together in certain mathematical or kindred figures what has in fact been perceived. (I say "perceived", for in the light of yesterday's lecture it would not be enough to say "seen".) All our geometry in this case, all of our measuring and mathematizing, must take its start from things perceived, observed. The only question is, are we conceiving the observed facts truly? We must really take it to heart — we must take knowledge of the fact — that in the scientific life and practice of our time what is observed, what is perceivable, is taken far to easily, too cursorily for a true conception to be gained.

Here for example is a question we cannot escape; it springs directly from the observable facts — (In the shortness of time these lectures have to be in bare outline and I have not been able to discuss or even to bring forward all the details. I could do little more than indicate directions.) Now among other things I have tried to show that the movements of heavenly bodies in celestial space must in some way be co-ordinated with what is formed in the living human body, and in the animal too in the last resort, we should by now perceive from the whole way the facts have been presented. And I assure you, the more deeply you go into the facts, the more of the connection you will see. Nevertheless, I have not done nor claimed to do any more than indicate the pathway (let me say again), the pathway along which you will be led to the result: The human living body, also the animal and plant body, are so formed that if we recognise the characteristic lines of form (as for example we did in tracing the Lemniscate in various directions though the human body) we find in them a certain likeness to the line-systems which we are able to draw amid the movements of the celestial bodies. Granted it is so, the question still remains however: What is it due to? How does it come about? What prospect is there for us not merely to ascertain it but to find it cogent and transparent, inherent in the very nature of things?

To get nearer to this question we must once more compare the kind of outlook which under-lay the Ptolemaic system and the kind that underlies the Copernican world-system of today.

What are we doing when we set to working the spirit of the latter system, and by dint of thinking, calculating and geometrising, figure out a world-system? What do we do in the first place? We observe. Out in celestial space we observe bodies which, from the simple appearance of them, we regard as identical. I express myself with caution, as you see. We have no right to say more than this . From the appearance of them to our eye, we regard these bodies (in their successive appearance) as identical. A few simple experiments will soon oblige you to be thus cautious in relating what you see in the outer world. I draw your attention to this little experiment; of no value in itself, it has significance in teaching us to be careful in the way we form our human thoughts.

Suppose it trained a horse to trot very regularly, — which, incidentally, a horse will do in any case. Say now I photograph the animal in twelve successive positions. I get twelve pictures of the horse. I put them in a circle, at a certain distance from myself, the onlooker. Over it all I put a drum with an aperture, and make the drum rotate so that I first see one picture of the horse, then, when the drum has totalled, a second picture, and so on. I get the appearance of a running horse, I should imagine a little

horse to be running round in a circle. Yet the fact is not so. No horse is running round; I have only been looking in a certain way at twelve distinct pictures of a horse, each of which stays where it is.

You can therefore evoke an appearance of movement not only by perspective but in purely qualitative ways. It does not follow that what appears to be a movement is really a movement. He then who wants to speak with care, who wants to reach the truth by scrupulous investigation, must begin by saying, whimsical as this may seem to our learned contemporaries: I look at three successive positions of what I call a heavenly body, and assume what underlies them to be identical. So for example I follow the Moon in its path, with the underlying hypothesis that it is always the same Moon. (That may be right without question, with such a "Standard" phenomenon, keeping so very regular a time-table!) What do we do then? We see what we take to be the identical heavenly body, in movement as we call it; we draw lines to unite what we thus see at different places, and we then try to interpret the lines. This is what gives the Copernican system. The school from which the Ptolemaic system derived did not proceed in this way, not originally. At that time the whole human being still lived in his perceiving, as I said yesterday. And inasmuch as man was thus alive and aware, perceiving with all his human being, the idea he then had of a heavenly body was essentially different from what it afterwards became.

A man who still lived thus perceivingly amid the Ptolemaic system did not say. There is the Moon up yonder. No, he did not; the people of today only attribute that idea to him, nor does it do the system justice. If he had simply said, "Up yonder is the Moon", he would have been relating the phenomenon to his whole human being, and in so doing the following was his idea: — Here am I standing on the Earth. Now, even as I am on the Earth, so too am I in the Moon, — for the Moon is here (Figure 1, lightly shaded area).

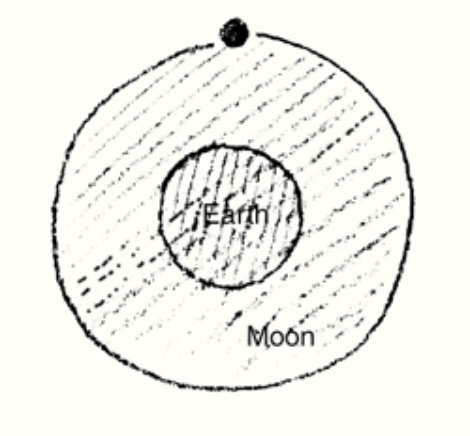

Figure 1

This (the small central circle in the Figure) is the Earth, whilst the whole of that is the Moon, — far greater than the Earth. The diameter (or semi-diameter) of the Moon is as great as what we now call the distance of the Moon (I must not say, of the Moon's centre) from the centre of the Earth. So large is the Moon, in the original meaning of the Ptolemaic system. Elsewhere invisible, this cosmic body at one end of it develops a certain process by virtue of which a tiny fragment of it (small outer circle in the Figure) becomes visible. They rest is invisible, and moreover of such substance that one can live in it and me permeated by it. Only at this one end of it does it grow visible. Moreover, in relation to the Earth the entire sphere is turning, (Incidentally it is not a perfect sphere, but a spheroid or ellipsoid-of-rotation. The whole of it is turning and with it turns the tiny reagent that is visible, i.e. the visible Moon. The visible Moon is only part of the full reality of it.

The idea thus illustrated really lived in olden time. The form at least, the picture it presents, will not seem so entirely remote if you think of an analogy, — that of the human or animal germ-cell in its development (Fig. 2).

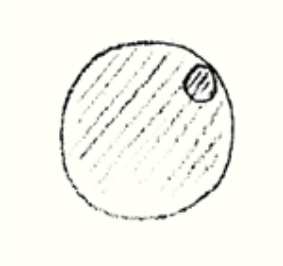

Figure 2

You know what happens at a certain stage. While the rest of the germinal vesicle is well-nigh transparent, at one place it develops the germinative area, so called, and from this area the further development of the embryo proceeds. Eccentrically therefore, near the periphery, a centre forms, from which the rest proceeds. Compare the tiny body of the embryo with this idea of the Moon which underlay the Ptolemaic system and you will have a notion of how they conceived it for it was analogous to this.

In the Ptolemaic conception of the Universe, we may truly say, quite another reality was ‘Moon’ — mot only what is contained in the Moon's picture, the illuminated orb we see. This, then, is what happened to man after the time when the Ptolemaic system was felt as a reality. The inner experience, the bodily organic feelings of being immersed in the Moon was lost. Today man has the mere picture before him, the illuminated orb out yonder. Man of the Fifth post-Atlantean Epoch cannot say, for he no longer knows it: “I am in the Moon, — the Moon pervades me”. In his experience the Moon is only the little illuminated disc or sphere which he beholds.

It was from inner perceptions such as these that the Ptolemaic system of the Universe was made: These perceptions we can henceforth regain if we begin by looking at it all in the proper light: we can re-conquer the faculty whereby the whole Moon is experienced. We must admit however, it is understandable that those who take their start from the current idea of ‘the Moon’ find it hard to see any such inner relation between this “Moon” and life inside them. Nay, it is surely better for them to reject the statement that there are influences from the Moon affecting man than to indulge in so many fantastic and unfounded notions.

All this is changed if in a genuine way we come again to the idea that we are always living in the Moon, so that what truly deserves the name of 'Moon' is in reality a realm of force, a complex of forces that pervades us all the time. Then it will no longer be a cause of blank astonishment that this complex of forces should help form both man and beast. That forces working in and permeating us should have to do with the forming and configuration of our body, is intelligible. Such then are the ideas we must regain. We have to realise that what is visible in the heavens is nor more than a fragmentary manifestation of cosmic space, which in reality is ever filled with substance. Develop this idea: you live immersed in substance — substances manifold, inter-related. Then you will get a feeling of how very real a thing it is. The accepted astronomical outlook of our time has replaced this 'real' by something merely thought-out, namely by 'gravitation' as we call it. We only think there is a mutual force of attraction between what we imagine to be the body of the moon and the body of the Earth respectively. This gravitational line of force from the one to the other — we may imagine it as it turns to get a pretty fair picture of what was called the 'sphere' in ancient astronomical conceptions — the Lunar sphere or that of any planet. This, then, has happened: What was once felt to be substantial and can henceforth be experienced in this way once more, has in the meantime been supplanted by mere lines, constructed and thought-out.

We must then think of the whole configuration of cosmic space — manifoldly filled and differentiated in itself — in quite another way than we are wont to do. Today we go by the idea of universal gravitation. We say for instance that the tides are somehow due to gravitational forces from

the Moon. We speak of gravitational force proceeding from a heavenly body, lifting the water of the sea. The other way of thought would make us say: The Moon pervades the Earth, including the Earth's hydrosphere. In the Moon's sphere, something is going on which at one place it manifests in a phenomenon of light. We need not think of any extra force of attraction. All we need think is that this Moon-sphere, permeating the Earth, is one with it, one organism all together , an organic whole. In the two kinds of phenomenon we see two aspects of a single process.

In yesterday's more historical lecture my object was to lead you up to certain notions, — essential concepts. I could equally well have tried to present them without recourse to the ideas of olden time, but to do so we should have had to take our start from premises of Spiritual Science. This would have led us to the very same essential concepts.

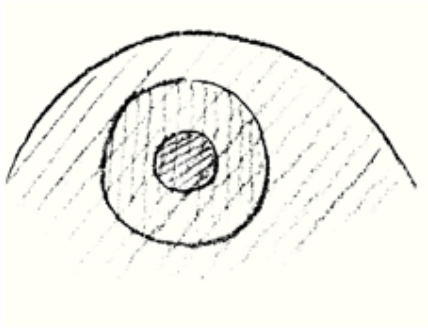

Figure 3

Imagine now (Fig. 3): Here is the Earth-sphere, — the solid sphere of Earth. And now the Lunar sphere: I must imagine this, of course, of very different consistency and kind of substance. And now I can go further. The space that is permeated by these two spheres, — I can imagine it permeated by a third sphere and a fourth. Thus in one way or another I imagine it to be permeated by a third sphere. It might for instance be the Sun-sphere, — qualitatively different form the Moon-sphere.

I then say I, am permeated — I, man, am permeated by the sun — and by the Moon-sphere. Moreover naturally there is a constant interplay between them. Permeating each other as they do, they are in mutual relation. Some element of form and figure in the human body is then an outcome of the mutual relation. Now you will recognise how rational it is to see the two things together: On the one hand, these different cosmic substantialities permeating the living body; and on the other hand the organic forms in which you can well imagine that they find expression. Form and formation of the body is then the outcome of this permeation. And what we see in the heavens — the movement of heavenly bodies — is like the visible sign. Certain conditions prevailing, the boundaries of the several spheres become visible to us in phenomena of movement.

What I have now put before you is essential for the regaining of more real conceptions of the inner structure of our cosmic system. Now you can make something of the idea that the human organisation is related to the structure of the cosmic system. You never gain a clear notion of it if you conceive the heavenly bodies as being far away yonder in space. You do gain a clear notion, the moment you see it as it really is. Though, I admit, it gets a little uncanny to feel yourself permeated by so many spheres, — just a little confusing!

And there is worse to come, for the mathematician at least. In effect, we are also permeated by the Earth-sphere itself, in a wider sense. For to the Earth belongs not only the solid ball on which we stand but all the volume of water; also the air, — this is a sphere in which we know ourselves to be immersed. Only the air is still very coarse, compared to the effects of heavenly phenomena. Think then of this: Here we are in the Earth-sphere, in the Sun sphere, in the Moon-sphere, and in others too. But let us single out the three, and we shall say to ourselves: Something in us is the outcome of the substantialities of these three spheres. Here then is qualitatively, what in its quantitative form is the mathematician's bugbear — the “problem of three bodies”, as it is called! It is working in us. In us is

the outcome of it, in all reality. We must face the truth: to read the hieroglyphic of reality is not so simple. That we are wont to take it simply and think it so convenient of access, springs after all from our fond comfort, — human indolence of thought. How many things, held to be "scientific", have their origin in this! Let go the springs of comfortableness, and you must set to work with all the care which we have tried to use in these lectures. If now and then, they do not seem careful enough, it is again because they are given in barest outline; so we have often had to jump from one point to another and you yourselves must look for the connecting links. The links are surely there.

Now you must set to work with equal care to tackle the same problem from another aspect to which I have referred before, namely the body of man compared to the creatures of the remaining Nature-kingdoms. We can imagine, I said, a line that forks out on either hand from an ideal starting-point. Along the one branch we put the plant-world, along the other the animal. If we imagine the evolution of the plant-world carried further in a real Kingdom of Nature, we find it tending towards the mineral. How real a process it is, we may recall by the most obvious example. In the mineral coal, we recognised a mineralised plant-substance. What should detain us from turning attention to the analogous processes which have undoubtedly taken hold of other realms of vegetable matter? Can we not also derive the siliceous and other mineral substances of the Earth in the same way, recognising in them the mineralisation of an erstwhile plant-life?

Not in the same way (I went on to say) can we proceed if we are seeking the relation of the animal to the human kingdom. Here on the contrary we must imagine it somewhat as follows. Evolution moves onward through the animal kingdom; then however it bends back, returns upon itself, and finds physical realisation upon a higher than animal level. We may perhaps put it this way: Animal and human evolution begin from a common starting — point, but the animal goes farther before reaching outward physical reality. Man on the other hand keeps at an earlier stage, man makes himself physically real at an earlier stage. It is precisely by virtue of this that he remains capable of further evolution after birth, incomparably more so then the animal. (For, once again, the processes of which we speak relate to embryo-development.) That man retains the power to evolve, is due to his not carrying the animal-forming process to extremes. Whilst in the mineral, the plant-forming process has overreached itself; in man on the contrary the animal-forming process has stopped short of the extreme. It has withheld, kept back, and taken shape at an earlier stage amid external Nature.

We have then this ideal point from which it branches (Fig. 6). There is the shorter branch and the longer. The longer is of undetermined length; the other, we may say, no less so, but negatively speaking. So then we have the mineral and plant kingdoms, and animal and human.

Now we must seek to gain a more precise idea: What is it that really happens, in this formation of man as compared to the animal? The process of development, once more, is kept back in man. It does not go so far; that which is tending to realisation is, as it were, made real before its time. Now think how it must be imagined according to what I have told you in these lectures. Study the share of the Solar entity in the forming of the animal body, — via the embryo-development, of course. You then know that the direct sunshine (so to describe it) has to do with the configuration of the animal head, whilst the indirect aspect of the sunlight, as it were the Sun's shadow by relation to the Earth, has in some way to do with the opposite pole of the creature. Strictly envisage this permeation of animal form and development with cosmic Sun-substantiality. Look at the forms as they are. Then you will gain a certain idea, which I shall try to indicate as follows.

Assume to begin with, — assume that in some way the forming of the animal is really brought about by relation to the Sun. And now, apart from the constellation that will be effective in each case as between Sun and animal, let us ask, quite in the sense of the Sun's light in the cosmos, not so immediately connected with the Sun itself? There is indeed. For every time the Full Moon, or the Moon at all, shines down upon us, the light is sunlight. The cosmic opportunity is being made then, so to speak, for the Sun's light to ray down upon us. It is so of course also when the human being comes into life — in the germinal and embyonal period. In earlier stages of Earth-evolution the influence was

most direct; today it is a kind of echo, inherited from then. Here then again we have an influence, in the other it is indirect, through the raying back of the Sun's light by the Moon.

Now think the following. I will again draw it diagrammatically. Suppose the development of the animal were such that it comes into being under the Sun's influence according to this diagram (Fig. 4).

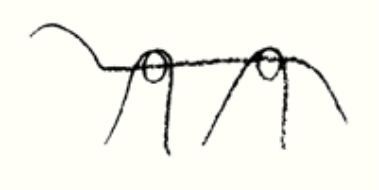

Figure 4

This then, to put it simply, would be the ordinary influence of day and night — head and the opposite pole of the creature. This, for the animal, would be the ordinary working of the Sun. Now take that other working of the Sun's light which occurs when the Moon is in opposition, i.e. when it is Full Moon, — when the Sun's light, so to speak works from the opposite side and by reflection counteracts itself. If we conceive this downward arrow (Fig. 5).

Figure 5

to represent the direction of the direct Sun-rays, animal formations, we must imagine animal-formation going ever farther in the sense of this direct Sun-ray. The animal would become animal, the more the Sun was working on it. If on the other hand the Moon is counteracting from the opposite direction — or if the Sun itself is doing so via the Moon, — something is taken away again from the animal-becoming process. It is withdrawn, drawn back into itself (Fig. 5a).

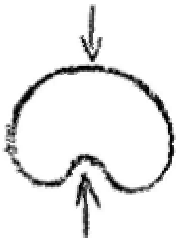

Figure 5a

Precisely this withdrawal corresponds to the shortening of the second branch in Figure 6. We have found a true cosmic counterpart of the characteristic difference between man and animal of which we spoke before.

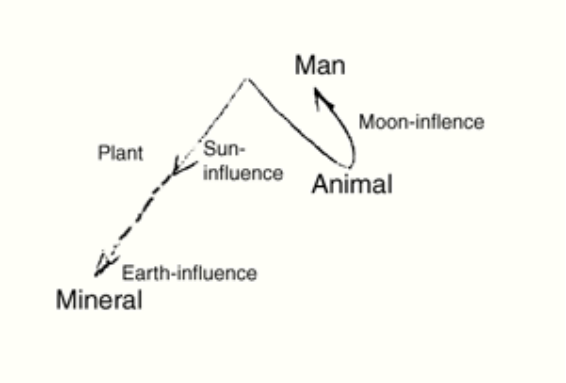

Figure 6

What I have just been telling you can be perceived directly by anyone who gains the faculty for such perception. Man really owes it to the counteracting of the Sunlight via the Moon. — owes it to this that his organisation is withheld from becoming animal. The influence of the Sun-light is weakened in its very own quality (for it is Sun-light in either case), in that the Sun places its own counterpart over against itself, namely the Moon and the Moon's influence. Were it not for the Sun meeting and countering itself in the Moonlight — influences, the tendency that is in us would give us animal form and figure. But the Sun's influence reflected by the Moon counteracts, it. The forming process is held in check, the negative of it is working; the human form and figure is the outcome.

Now, on the other branch of the diagram, let us follow up the plant and the plant-formative process. That the Sun is working in the plant, is palpably evident. Let us imagine the Sun's effect in the plant, not to be able to unfold during a certain time. During the Winter, in fact, the springing and sprouting life in the plant cannot unfold. Nay, you can even see the difference in the unfolding of the plant by day and night. Now think of this effect in oft-repeated rhythm, repeated endless times, — what have we then? We have the influence of the Sun and the influence of the Earth itself; the latter when the Sun cannot work directly but is hidden by the Earth. At one time the Sun is working, at another it is not the Sun but the Earth, for the Sun is working from below and the Earth is in the way. We have the rhythmic alternation: Sun-influence predominant, Earth-influence predominant in turn. Plant-nature therefore is alternately exposed to the Sun, and then withdrawn, figuratively speaking, into the Earth — drawn by the earthly, as it were, into itself. This is quite different from what we had before. For in this case the Sun-quality, working in the plant, is potently enhanced. The solar quality is actually enhanced by the earthly, and this enhancement finds expression in that the plant gradually falls into mineralization.

Such then is the divergence of two ways, as indicated once again in Figure 6. In the plant we have to recognize the Sun's effect, carried still further by the Earth, to the point of mineralization. In the animal we have to recognize the Sun's effect, which then in man is drawn back again, withdrawn into itself, by virtue of the Moon's effect. I might also draw the figure rather differently, like this (Fig. 6a),

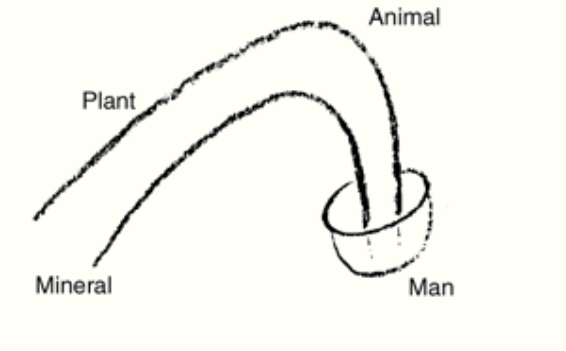

Figure 6a

— here receding to become human, here on the other hand advancing to become mineral, which of course ought to be shown in some other form. It is no more than a symbolic figure, but this symbolic figure, tends to express more clearly than the first, made of mere lines, the bifurcation — as again I like to call it — with the mineral and plant kingdoms upon the one hand, the human and animal upon the other.

We never do justice to the true system of Nature with all her creatures and kingdoms if we imagine them in a straight line. We have to take our start from this other picture. In the last resort, all systems of Nature which begin with the mineral kingdom and thence going on to the plant, thence to the animal and thence to man as if in a straight line, will fail to satisfy. In this quaternary of Nature we are face to face with a more complex inner relationship than a mere rectilinear stream of evolution, or the like, could possibly imply. If one the other hand we take our start from this, the true conception, then we are led, not to a generatic aequivoca or primal generation of life, but to the ideal centre somewhere between animal and plant — a centre not to be found within the physical at all, yet without doubt connected with the problem of three bodies, Earth, Sun and Moon. Though perhaps mathematically you cannot quite lay hold on it, yet you may well conceive a kind of ideal centre-of-gravity of the three bodies — Sun, Moon and Earth. Though this will not precisely solve you the 'problem of three bodies', yet it is solved, namely in Man. When man assimilates in his own nature what is mineral and animal and plant, there is created in him in all reality a kind of ideal point-of-intersection of the three influences. It is inscribed in man, and that is where it is beyond all doubt. Moreover inasmuch as it is so, we must accept the fact that what is thus in man will be empirically at many places at once, for it is there in every human being, — every individual one. Yes, it is there in all men, scattered as they are over the Earth; all of them must be in some relation to Sun and Moon and Earth. If we somehow succeeded in finding an ideal point-of-intersection of the effects of Sun and Moon and Earth, if we could ascertain the movement of this point for every individual human being, it would lead us far indeed towards an understanding of what we may, perhaps, describe as movement, speaking of Sun and Moon and Earth.

As I said just now, the problem grows only the more involved, for we have so many points, — as many as there are men on Earth, — for all of which points we have to seek the movement. Yet it might be, might it not, that for the different human beings the movements only seemed to differ, one from another ...

We will pursue our conversations on these lines tomorrow.

Lecture XV
Stuttgart, January 15, 1921

My Dear Friends,

Today I will deal with some of the things that may be causing you difficulty in understanding what we have done hitherto. I will lead over from these difficulties into a realm of ideas which will show up the inadequacy of those lines of thought on which the people of our time, with all their comfortable mental habits, would gladly found their understanding of universal phenomena.

We have been studying the universal phenomena in their relation to man. We have done so in manifold directions. Again and again we have indicated how a relationship reveals itself between the forming of man and what appears in the celestial phenomena. Whether we go by some ancient cosmic system of by the Copernican theories in forming our pictured synthesis of the movements of heavenly bodies, we must relate the picture to man in diverse ways of course, accordingly. This we have seen. For a true Science we must accept that there is this relation.

Yet the difficulties are formidable. Earlier in these lectures we drew attention to one such difficulty. The moment we try to form ratios between the periods of revolution of the planets of our system we come to incommensurable numbers. Arithmetic runs out, as we might say; we get no farther with it, for where incommensurable numbers enter in there is no palpable unit. Thus, when we look for a synthesis of the phenomena of cosmic space with our accustomed mathematical method and way of thinking, the phenomena themselves are such that we find ourselves driven farther and farther from reality. We may not therefore take for granted that we shall ever be able to explain the cosmic phenomena on the accustomed basis of our Geometry, that is to say, within a rigid three-dimensional space. Nay more, another difficulty has emerged. Yesterday we found ourselves obliged to assume a certain relationship of Sun and Moon and Earth, finding expression in some way in man — in man's very structure. We would fain grasp how the relation is. Yet if we posit this working-together of the Three*, we get into formidable difficulties in spatial calculation.

All these things we have mentioned. Now we can reach a certain starting-point at least, through pure Geometry — yet a Geometry of a higher kind. Thence we may gain an idea of where the difficulties come from when we are trying by dint of spatial calculation to grasp the inter-connection of celestial phenomena. Let us recall our precious attempts to comprehend the form of man himself. We are then let to this:- We can and we should try to take seriously that 'memberment' of the human being of which we have also spoken in these lectures. The human head-organization, we may truly say, centring as it does in the nerves-and-senses system, is relatively independent. So is the rhythmic system with all that belongs to it. The metabolic system too, and all that goes with it in the organization three independent systems are revealed. Taking our start now in an intelligent way from the principle of metamorphosis, as we must always do when dealing with organic Nature, we can try to form ideas upon this question: How are the three members of the three-fold human system related to each other, according to this principle of metamorphosis?

Understand me rightly, my dear friends. We want to gain an idea-though it be only pictorial to begin with — of how the three members of the human system are related to each other. On the face of it, it will of course be difficult. Such organs as are met with in the human head, it will be difficult to recognise in them at all clearly the metamorphosis of those organs which are fundamental to the metabolic and lymph system. But if we go into the morphology of man deeply enough, we can find our way. We only have to think most thoroughly along the lines already indicated. Namely, the essence of the mutual relation of the long bone to the skull-bone and vice-versa is a complete turning-inside-out. The inner surface of the bone becomes the one turned outward. It is the principle by which you turn a glove inside-out, provided only that the turning-inside-out involves a simultaneous change in the inherent relationships of inner forces. If I should turn a tubular bone or long bone inside-out like a mere glove, I should again get the form of a tubular bone, needless to say. But it will not be so if we

take our start, as we must do, from the inherent configuration of the bone. As I described before, in its inherent configuration the long bone is oriented inward towards the radial quality that runs right through it. It is obliged therefore to subject its material structure and arrangement to the radial principle. When I have "flipped" it, so that the inner side opens outside, in its configuration it will no longer follow the radial but the spheroidal principle. The "inner side", now turned outward towards the Sphere, will then receive this form (Fig. 1).

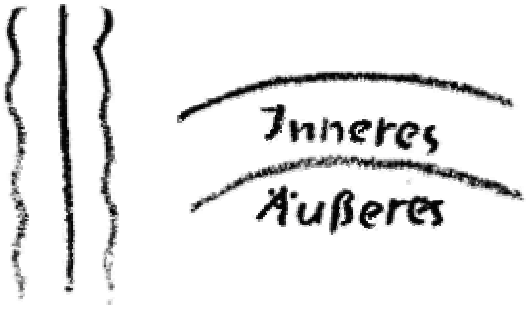

Figure 1

What was outside before, is now inside, and vice-versa. Take this into account for the extreme metamorphosis-tubular bone into skull-bone and you will say: The outermost ends of human memberment — lymph-system and skull system — represent opposite poles in man's organization. But we must not think of "opposite poles" in the mere trivial, linear sense of the word. In that we go from one pole to the other, we must adopt the transition which this involves, namely from Radius to surface of a Sphere. Without the help of such ideas and mental pictures, intricate as they may seem, it is quite impossible to gain a just or adequate notion of what the human body is.

We come now to what constitutes the middle, in a certain sense, — the middle member of man's organization. This will be all that belongs to the rhythmic system, and it will somehow form the transition from radial structure to spheroidal.

In the threefold system thus presented we have the key to the morphological understanding of the entire human organism. Of course we need to realise how it will be. Suppose we have some organ in the metabolic system — the liver for example — or any one of the organs mainly assigned to the metabolism. (We must qualify it with the word 'mainly' for there is always an overlapping and interlocking of these things). Suppose then we begin with such an organ and seek what answers to it in the head. We try to find which of the organs in the head-nature of man m ay be connected with it by the metamorphosis of turning-inside-out. We shall then have to recognise the organ when entirely transformed, de-formed; only by so doing shall we understand it. It will therefore not be easy to take hold of mathematically. Yet without finding some mathematical way of access we shall never adequately grasp it. And if you call to mind (even if you only take this as a picture) — if you call to mind that the real understanding of the human form and figure will lead us out among the movements of celestial bodies, you will divine what must be needful also when we wish to comprehend the latter. For a true synthesis of the phenomena of movement among the heavenly bodies, it will be quite inadequate to think of them as if these movements were accessible to a Geometry that simply reckons with ordinary rigid space and therefore cannot master the turning-inside-out. For when we speak of a turning-inside-out in the way we have been doing, we can no longer be thinking of ordinary space. Ordinary space holds good where we can calculate volumes, cubicle contents in the conventional way. We cannot do so if obliged to make the inner outer. We can no longer go on calculating them with the same conceptions which hold good in ordinary space.

If then in thinking of the human form and figure I need the turnings-inside-out, in thinking of the movements of heavenly bodies I shall need them too. I cannot proceed like the current Astronomy which tries to comprehend the celestial phenomena within an ordinary rigid form of space.

Take, to begin with, simply the head-organization and the metabolic organization of man. To pass from one to the other you must imagine, once again, a turning-inside-out — and, what is more, one that involves variations of form. Let us at least try to get a picture of the kind of think involved. We did preliminary work in this direction when speaking of the Cassini curves, and of the circle differently conceived. Ordinarily the circle is defined as a curve, all of whose points are equidistant from one central point. We were speaking of the circle as a curve, all of whose points are at measured distances from two fixed points, and so that the quotient of the two distances is constant. This was our other conception of the circle.

Speaking of the Cassini curve, we showed that it has three essential forms. One, not unlike an ellipse: — this form arose when the parameters of the curve bore a certain relation, the which we indicated. The second form was the lemniscate. The third form is that while in the idea of it — and also analytically — it is a single entity, to look at it is not. It has two branches (Fig. 2),

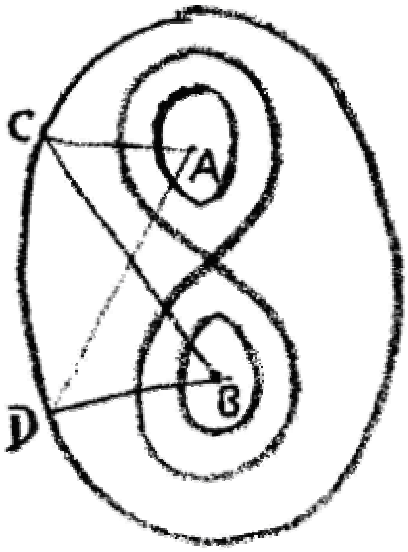

Figure 2

yet the two branches are one curve. To draw the line, we should somehow have to go out of space, coming back into space again when we draw the second branch. Conceptually, our hand would be drawing a continuous line when drawing the two regions which look separate. We cannot draw the line continuously within ordinary space, and yet conceptually what is here above and what is here below (the inner curve in Figure 2) is a single line. Now as I also mentioned, the same curve can be thought of in another way. You can ask what will be the path of a point which when illumined from a fixed point A appears with constant intensity of illumination, seen from another fixed point B. Answer: a Cassini curve. A curve a Cassini will be the focus of all points through which a point must run, if when illumined from a fixed point A it is seen ever with the same intensity of light from another fixed point B (Fig. 2 again).

Now it will not be hard for you to imagine that if something shines from A to C (Fig. 2) and thence by reflection from C to B, the intensity of light will be the same as if reflected from D instead. But it gets rather more difficult to imagine when you come to the Lemniscate. The ordinary geometrical constructions by the laws of reflection and so on, will not be quite so easy to carry through. And it gets still more difficult to imagine with the two-branched curve, that the same intensity of light should always be observed from the point B, inside the one branch of the curve, when the original point-source of light is in A. You would have to imagine (as you pass from the one branch to the other) that the ray of light goes out of space and then shines into space again. You are up against the same difficulty as before, when you were simply asked to draw the two branches as one — with a single sweep of the hand through space.

Yet if we do not develop these conceptions we shall be unequal to the other task, namely of finding the transmutation — or even the mere relationship of form — as between any organ in the head of man and the corresponding organ in the metabolism. To find the connection you simply must go out of space. Once again — strange as it may sound — if with your understanding of any form in the human head you wish to make transition to the understanding of a form in the human metabolic system then you will not be able to remain in sorce. You must get out of space. You must get right out of yourself , looking for something that is not there in space. You will find something that is as little inside ordinary space as is what intervenes between the upper and lower branches of a two-branched Cassini curve. This is in fact only another way of expressing what was said before that the metamorphosis must be so conceived as to turn the form completely inside out.

In thinking thus of the connection between the upper and lower branches of the discontinuous curve of Cassini (as shown in Fig. 3) we are still presupposing actual constants, rigid and unchanged, in the equation. Now if we vary the constants themselves as in an earlier lecture, forming equations of twofold variability, we shall be able to imagine the upper branch say, in this form and the low one in this (Fig. 3).

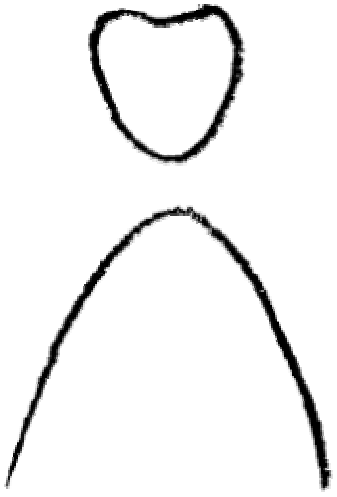

Figure 3

The upper branch will take this form eventually. If then you alter the curve of Cassini by taking variables in place of constants — so that you start with equations instead of starting with invariable constants — you will get two different kinds of branches. Then there will also be the possibility for one of the two branches to come in as it were from the infinite and go out to the infinite again. This is precisely the relationship from which you should take your start when following certain forms within the human head, comprising them in curves and lines, and then relating them to the forms of organs or of complexes of organs in the metabolic system, which in their turn you will comprise in curves and lines. Such is the intricacy of the human form. To make it still less simple, you must imagine the one line (Fig. 3a) with an outward tendency and the other with its tendency turned inward.

You will be prone to say (I hope without insisting on it, but as a passing impression): If this be so, the human organization is so complicated that one would almost prefer to do without such understanding and fall back on the ordinary philistine idea of the body, as in the present-day Anatomy and Physiology. There we are not called upon to make such prodigious efforts, as to let mental pictures vanish and yet again not vanish, or turn them inside-out, and all the rest! May be; but then you never really understand the human form; your understanding is, at most, illusionary.

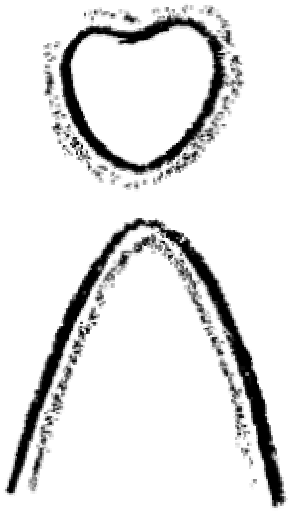

Figure 3a

Now, to go on: Suppose you thus look into it and recognize that there is something in the human organization which falls right out of space, is not in space at all, but obliges you for instance to imagine spatially separated line-systems, inherently united with each other and yet united by another principle than three dimensional space affords. Thinking in this way, you will no longer be too far removed from what I shall now bring forward. You will at least be able to entertain the thought in a formal sense. No-one, I mean can validly object to thinking it as a pure form of thought. For to begin with, all we are called upon to do is to conceive a clear idea, as in mathematics generally. It cannot be objected that the thing is unproved, or the like. We are only concerned to reach a self-contained and consistent idea.

Think therefore for a moment that you had to do not only with ordinary space, conceived in its three dimension, but with a "counter-space" or anti-space". Let me call it so for the moment, and I will try to evoke an idea of it, as follows. Suppose I form the thought of ordinary, three-dimensional, rigid space. I form the first dimension, I form the second dimension and I form the third dimension (Fig. 4).

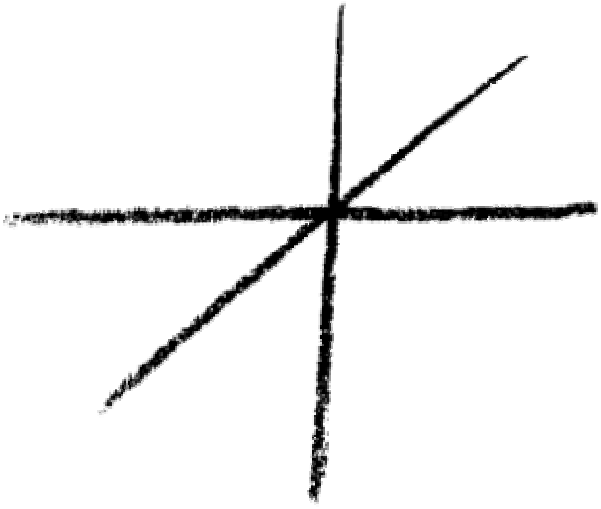

Figure 4

Then I have, so to speak, filled-in in thought — in the idea and mental presentation of it — three-dimensional space with which I am ordinarily confronted. Now as you know, in any such domain you can not only advance up to a certain degree of intensity; you can subtract from it too, and as you go on subtracting — taking away — you come at last to the negation of ti. As you are well aware, there is not only wealth but debt. Likewise I cannot only make the three dimensions to arise in thought but I can also make them vanish. Only I now imagine the arising and vanishing to be a real process, — something hat is really there. Of course it is possible to think only two dimensions instead of three, but that is not my meaning. What I now mean is this: The reason why I only have two dimensions (Fig. 4a)

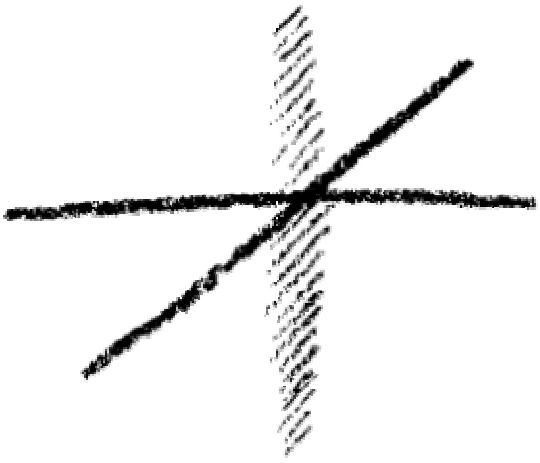

Figure 4a

is not that I never had a third. The reason is, I had a third and it has vanished. The two dimensions are an outcome of the coming-into being and vanishing-again of the third. I now have a space, which, though it outwardly shows only two dimensions, must inwardly be conceived as having two third dimensions, one positive and the other negative. The negative dimension springs from a source that can no longer be there in my three-dimensional space at all. Nor must I think of it as a "fourth dimension" in the conventional sense. No, I must think of it as being, to the third dimension, as positive to negative (Fig. 4a once more).

And now suppose that what I have been indicating is really there in the Universe; yet, as things generally are in the real world, approximately so. It would then be not a pedantically accurate but an approximate rendering of what I have here drawn. This need not cause you any great surprise, for in outer sense-perceptible reality you never find mathematical figures reproduced in any other way, always approximately. If then I claim that the picture represents something real, you will only expect it to do so in an approximate sense. To represent a reality corresponding to it, I need not repeat exactly the same drawing, but I should have to draw something flattened; that would answer to it. The fact that something has been there and has then vanished, I may perhaps suggest in this way: I will suppose that the density of an effect, indicated by the dark shading, came into being and then partly faded out again, drew weaker (Fig. 5).

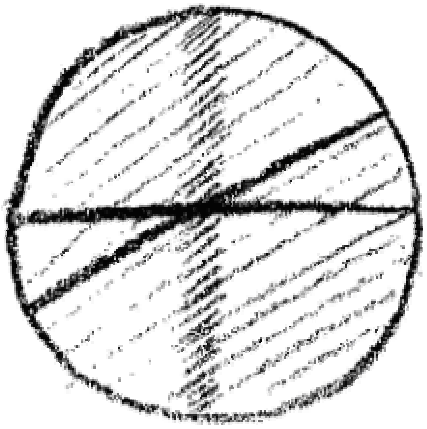

Figure 5

You are then left with a sphere that has a denser portion in the middle region. I beg you know, compare what is here drawn with the real cosmic system, such as we see it with our eyes, — the cosmic sphere with all the stars widely dispersed, and then the stars more densely packed in the region of the Milky Way, or what we call the Galactic System.

Yet you may also compare it with something else. Take any popular star-map. The picture we have shown (Fig. 5a)

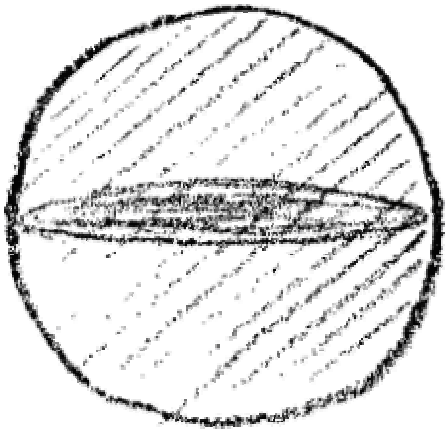

Figure 5a

— let us still take it simply as a picture — is fundamentally equivalent to what is always being shown: the passage of the Sun or of the Earth through the Zodiac, with the with the North and South poles of the ecliptic somewhere out yonder. The idea we have been forming is, as you see, not so very remote from what is there in the outer Universe. In coming lectures we shall of course still have to look for more detailed relations.

Now for an understanding of what was said before about the human being we have not yet gone for enough. We must go farther and make the second dimension also vanish; so then we shall be left with only one, — with a straight line. But this is no ordinary straight line drawn into three-dimensional space. It is the line that has remained when we have made the third and also the second dimension vanish. And now we make the last remaining one to vanish. Then we are left with a mere point. Bear in mind however that we have arrived at the point by the successive vanishing of three dimensions. Now let us suppose that this point were to present itself to us in reality, — as having existence in itself. If it is there, and making itself felt, how then shall we imagine its activity? We cannot relate its

activity to any point in the space determined by the x-axis. The x-axis is not there, since it has vanished. Nor can we relate it to anything with an x — and a y-coordinate, for all of this has gone; all this has vanished out of space. Nor can we relate it in its activity to the third dimension of space. What then shall we say? When it reveals its activity we shall have to relate it to what is quite outside three-dimensional space. What then shall we say? When it reveals its activity we shall have to relate it to what is quite outside three-dimensional space. Consistently with the procedure we have been through in our thinking, we cannot possibly relate it to anything that could still be included in this space. We can only relate it to what is outside it three-dimensional space altogether. We can relate it neither to "x deleted" nor to "y deleted" not to "z deleted", but only to what deletes all three of them, z, y, and z together, and is therefore into within three-dimensional space at all.

We put this forward to begin with as a purely formal, mathematical notion. Yet is soon grows real. It grows exceedingly real when we begin to enter into things more deeply than with the easy-going notions with which Science nowadays would gladly master them. Look, with this deeper tendency of understanding, — look at the process of sight and the whole organisation of the eye. You are perhaps aware (in other lectures I have often spoken of it) of how the eye is not merely to be regarded as a thing formed from within the body outward; for it is largely organized into the body from outside. You an trace the forming of it from without inward by studying the phylogenetic development of lower animals and then considering the act of sight itself. You will contrive to understand how the process of sight is stimulated from without and how the organ too is adapted to this stimulation from without. Then as the process works on inward to the optic nerve and farther in, it vanishes at length, — vanishes as it were into the organisation as a whole. I know you can find the termination of the optic nerves, and yet — this too comes to expression approximately — if you go into the inner organisation you will have to admit that it there vanishes.

So much for the process of sight and the associated organs. And now compare with this the process of secretion of the kidneys. Go into it conscientiously. and you will have to relate the duct that leads outward, for the secretion of the kidneys, to what is working from without inward where the eye passes into the optic nerve. If you then look for ideas whereby the two things can be related, so that their mutual relation will help you understand the phenomena of either process, you will find indispensable such forms of thought as we have just been indicating. If you conceive the ideas of three-dimensional space as applying to the process of sight (we might also replace the one by the other, but if you do it in this way. ...), then, if you seek what answers to it in the secretion of the kidneys, you must realize that what is there enacted takes you right out of three-dimensional space. You must go through the same procedure in your thinking as I did just now in extinguishing the spatial dimensions. Otherwise you will not find your way.

In like manner you must proceed if you are trying to understand the curves formed in the Heavens by the apparent paths of Venus and Mercury on the one hand, Jupiter and Mars on the other, I mean quite simply the apparent paths as we observe them with our eyes, — the loops and all. If you use polar coordinates for example, then for the loop of Venus you may make the origin of your coordinate system in three-dimensional space. Here you can do so. But you will not come to terms with reality if you adopt the same principle when examining the curve of Mars. In this case you must start from the ideal premise that the origins of any relevant system of polar coordinates will be outside three-dimensional space. You are obliged to take the coordinates in this way. In the former case you may start from the pole of the coordinate system, taking coordinates in the normal way, as in Figure 6.

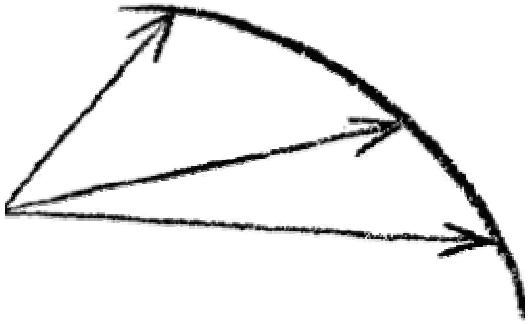

Figure 6

But if you do this for the one planetary curve — say for the path of Venus with its loop — you will do equal justice to the paths of Jupiter or Mars with their loops, only by saying to yourself: This time I will not pre-suppose a polar-coordinate system with an origin such that I always have to add a piece to get the polar-coordinates, as in Figure 6. No, I will take as origin of my polar-coordinate system the encompassing Sphere (Fig. 6a),

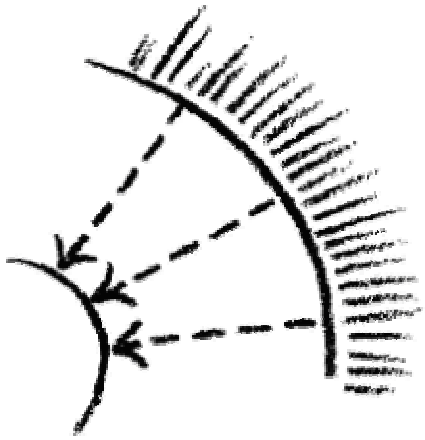

Figure 6a

i.e. what is there behind it, indeterminately far. Then I get such coordinates as these (dotted lines), where in each case, instead of adding, I must leave so much out. The curve I then obtain also has something like a centre, but the centre is in the infinite sphere.

It might prove necessary then, for more profound research into the paths of the planets, that we make use of this idea: In constituting the paths of the inner planets we must indeed attribute to these paths some centre or other within ordinary space. But if we want to think of centres for the path of Jupiter, the path of Mars and so on, we must go right outside this ordinary space.

In fine, we have to overcome space; we must transcend it . There is no help for it. If you are conscientious in your efforts to comprehend the phenomena, the mere ideas of three-dimensional space will not suffice you. You must envisage the interplay of two kinds of space. One of them, with the ordinary three dimensions, may be conceived as issuing radially from a central point. The other, which is all the time annulling and extinguishing the first, may not be thought of as issuing from a point at all. It must be thought of as issuing from the encompassing Sphere — that is, the Sphere infinitely far away. While in the former case the "point" is of zero areas which it turns outward, and a point with the area of an infinite spherical surface which it turns inward. Geometrically it may suffice to conceive the notion of a point abstractly. In the realm of reality it will not. We shall not do justice to reality with the mere notion of an abstract point. In every instance we must ask whether the point we

are conceiving has its curvature turned inward or outward; its field of influence will be according to this.

But you must think still farther, my dear friends; there is a another thing. Of course you may imagine that you had somewhere caught this point which is really a Sphere. To begin with, since it is in the infinite far spaces you need not imagine it just here (s, Fig. 7). You can equally well imagine it a little farther out, (b, or c). You can imagine it to be anywhere out there; you only have to leave this sphere free (strongly drawn sphere in Fig. 7).

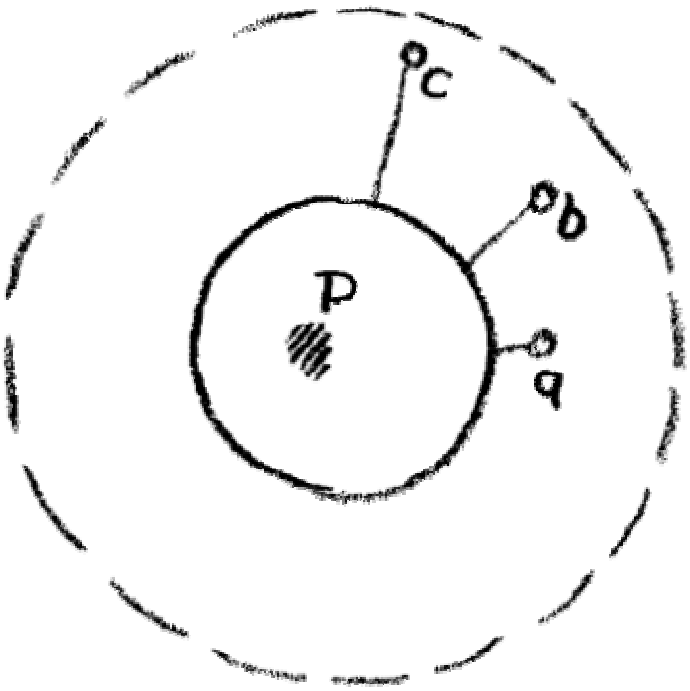

Figure 7

For this is hollowed out, so to speak; this is the inverted circle or the inverted sphere, if you like. But now suppose the following might be the case. Think of what is within this peculiar circle (namely at a, b, c, etc,) Think of this point that has its curvature turned inward. For in effect, the entire space outside this spherical surface is then a point with its curvature turned inward. And now imagine that this space had, after all, its limit somewhere. You might be able to go far away out, — very far. Suppose however the reality were such that you could not just go anywhere, but somewhere after all there was a limit of quite another kind (dotted circle in Figure7). What there would appear, as if by inner necessity, what in effect belongs to the realm beyond the limit. An equivalent sphere would have to arise within, belonging to what is there outside. You would then have to realize: Out there, beyond a certain sphere, something is still existing, it is true, but if I want to see it I must look in here (P), for here it re-appears. The continuation of what is faraway out there make itself felt in here. What I am looking for as I go out into infinite distances, makes its appearance within, and becomes manifest to me from this centre.

These are the kind of ideas you should develop to an adequate extent. In a formal sense they look sound enough. As forms of thought there can surely be no objection to them. Truly remarkable results will be obtained however, if with their help you try to penetrate outer reality. Think for example that there might be a phenomenon in celestial space, — we may call it "Moon" to begin with, — yet this phenomenon were not to be understood simply by saying: "This Moon is a body, here is its central point; we will investigate it on the understanding that it is a body and that its central point is here."

Assume (and please forgive my saying, I put it euphemistically) assume that this way of thinking did not fit the reality, but that I ought to express it quite differently. I ought rather to say: "If I, in my Universe, start from a certain point and go farther and farther out, I come at length to where I shall no longer find heavenly bodies. Yet neither shall I find a mere empty Euclidean space. No, I shall find something, the inherent reality of which obliges me to recognize the continuation of it here (at P)." I should then be obliged to conceive the space contained within the Moon as a portion of the entire Universe with the exception of all that exists by way of stars, etc., outside the Moon. I should have to think on the one hand of all the stars here are in cosmic space. These, I am now assuming I have to treat in one way, according to a single principle; but the inside of the Moon — the space contained within the Moon — could not be treated in this way. It would require me to think as follows: There on the one hand I go out into the far spaces. Somewhere out there, I presume, is the celestial Sphere. Though it be only the "apparent" Sphere to begin with; something effective, something real must be conceived to underlie it. Yet whatsoever realities I find out there, the space within the spherical surface of the Moon has nothing whatever to do with it. It only has to do with what begins where the stars come to an end. It is a fragment, in some strange way, belonging not to my Universe but to that Universe to which all the stars do not belong.

If there is such a thing within a Universe, it is a thing inserted in this Universe, occluded as it were, — thing of altogether different nature and revealing different inner properties from all that is there around it. And we may then compare the relation of such Moon to its surrounding Heavens with the relation which obtains for instance between the secretions of the kidneys — with the organic structure that underlies them — and on the other hand the structure and functioning of the eyes. From this we shall proceed tomorrow.

It is not due to me that I must try to form, and to acquaint you with, such complicated notions of how the Universe is built. Truth is, equipped with any other notions you will not make headway, save on the convention: "Let us comprise the phenomena with our given range of ideas, and if we come to a limit somewhere, well then we do, and we go no further". Ascribe it then to the reality and not to any craving for remote ideas, if in the effort to impart an understanding of how the Universe is built I have unfolded complicated notions.

Lecture XVI
Stuttgart, January 16, 1921

My Dear Friends,

What we are doing, as you will have seen, is to bring together the diverse elements by means of which in the last resort we shall be able to determine the forms of movement of the heavenly bodies, and — in addition to the forms of movement — what may perhaps be described as their mutual positions. A comprehensive view of our system of heavenly bodies will only be gained when we are able to determine first the curve-forms (inasmuch as forms of movement are called curves), i.e. the true geometrical figures, and then the centres of observation. Such is the task before us along our present lines of study, which I have formed as I have done for very definite reasons.

The greatest errors that are made in scientific life consist in this: they try to make syntheses and comprehensive theories when they have not yet established the conditions of true synthesis. They are impatient to set up theories — to gain a conclusive view of the thing in question, — they do not want to wait till the conditions are fulfilled, subject to which alone theories can properly be made. Our scientific life and practice needs this infusion badly, — needs to acquire a feeling of the fact that you ought not to try and answer questions when the conditions for an intelligent answer are not yet achieved. I know that many people (present company of course excepted) would be better pleased if one presented them with curves all ready made, for planetary or other movements. For they would then be in possession of tangible answers. What they are asking is in effect to be told how such and such things are in the Universe, in terms of the ideas and concepts they already have. What if the real questions are such as cannot be answered at all with the existing ideas and concepts? In that case, theoretic talk will be to no purpose. One's question may be set at rest, but the satisfaction is illusionary. Hence, in respect to scientific education, I have attempted to form these lectures as I have done.

The results we have gained so far have shown that we must make careful distinctions if we wish to find true forms of curves for the celestial movements. Such things as these, for instance, we must differentiate: the apparent movements seen in the paths of Venus and of Mars respectively, — Venus making a loop when in conjunction, Mars when in opposition to the Sun. We came to this conclusion when trying to perceive how diverse are the forms of curves that arise in man himself through the forces that build and form him. We ascertained quite different forms of curve in the region of the head-nature and in the organization of the metabolism and the limbs. The two types of form are none the less related, but the transition from one to the other must be sought for outside of space, — at least beyond the bounds of rigid Euclidean space.

Then comes a further transition, which still remains for us to find. We have to pass from what we thus discover in our own human frame, to what is there outside in Universal Space, which only looks to us plainly Euclidean. We think it nicely there, a rigid space, but that is mere appearance. As to this question, we only gain an answer by persevering with the same method we have so far developed. Namely we have to seek the real connection of what goes on in man himself and what goes on outside in Universal Space, in the movements of the celestial bodies. Then we are bound to put this fundamental question: What relation is there, as to cognition itself, between those movements that may legitimately be considered relative and those that may not? We know that amid the forming and shaping forces of the human body we have two kinds: those that work radially and those which we must think of as working spherically. The question now is, with regard to outer movements: How, with our human cognition do we apprehend that element of movement which takes its course purely within the Sphere, and how do we apprehend that element which takes its course along the Radius?

Figure 1

A beginning has been made in Science as you know, even experimentally, in respect of these two kinds of spatial movement. The movements of a heavenly body upon the Sphere can of course be seen and traced visually. Spectrum analysis however also enables us to detect those movements that are along the line of sight, spectrum analysis enables us to recognise the fact. Interesting results have for example been arrived at with double stars that move around each other. The movement was only recognizable by tackling the problem with the help of Doppler's principle, — that is the experimental method to which I am referring.

For us, the question now is whether the method which includes man in the whole cosmic system will give us any criterion — I express myself with caution — any criterion to tell whether a movement may perhaps only be apparent or whether we must conclude that it is real. Is there anything to indicate that a given movement must be a real one? I have already spoken of this. We must distinguish between movements that may quite well be merely relative and on the other hand such movements as the "rotating, shearing and deforming movements" (so we described them), the very character of which will indicate that they cannot be taken in a merely relative sense. We must look for a criterion of true movement. We shall gain it in no other way than by envisaging the inner conditions of what is moving. We cannot possibly confine ourselves to the mere outer relations of position.

A trite example I have often given is of two men whom I see side by side at 9 am and again at 3 in the afternoon. The only difference is, one of them stayed there while the other went on an errand lasting six hours. I was away in the meantime and did not see what happened. At 3 pm I see them side by side again. Merely observing where they are outwardly in space, will never tell me the true fact. Only by seeing that one is more tired than the other — taking account of an inner condition therefore — shall I be able to tell, which of them has been moving. This is the point. If we would characterize any movement as an inherent and not a merely relative movement, we must perceive what the thing moved has undergone in some more inward sense. For this, a further factor will be needed, of which tomorrow. Today we will at least approach the problem.

We must in fact get hold of it from quite another angle. If we in our time study the form and formation of the human body and look for some connection with what is there in cosmic space, the most we can do to begin with is in some outward sense to see that the connection is there. Man is today very largely independent of the movements of cosmic space; everything points to the fact that this is so. For all that comes to expression in his immediate experience, man has emancipated himself from the phenomena of the Universe. We therefore have to look back into the time when what he underwent depended less upon his conscious life of soul than in his ordinary, by which I mean, post-natal life on Earth. We must look back into the time when he was an embryo. In the embryo the forming and development of man does indeed take place in harmony with cosmic forces. What afterwards remains is only what is carried forward, so to speak. Implanted in the whole human organization during the embryonal life it then persists. We cannot say it is "inherited" in the customary sense, for in fact nothing is inherited, but we must think of some such process, where entities derived from an earlier period of development stay on.

We must now look for an answer to the question: Is there still anything in the ordinary life we lead after our birth — after full consciousness has been attained — is there still any hint of our connection with the cosmic forces? Let us consider the human alternation of waking and sleeping. Even the civilized man of today still has to let this alternation happen. In its main periodicity, if he would stay in good health, it still has to follow the natural alternation of day and night. Yet as you know very well, man of today does lift if out of its natural course. In city life we no longer make it coincide with Nature. Only the country folk do so still. Nay, just because they do so, their state of soul is different. They sleep at night and wake by day. When days are longer and nights shorter they sleep less; when nights are longer the sleep longer. These aspects however can at most lead to vague comparisons; no clear perception can be derived from them. To recognize how the great cosmic conditions interpenetrate the subjective conditions of man, we must go into the question more deeply. So shall we find in the inner life of man some indication of what are absolute movements in the great Universe.

I will now draw your attention to something you can very well observe if only you are prepared to extend your observation to wider fields. Namely, however easily man may emancipate himself from the Universe in the alternation of sleeping and waking as regards time, he cannot with impunity emancipate himself as regards spatial position. Sophisticated folk — for such there are — may turn night into day, day into night, but even they, when they do go to sleep, must adopt a position other than the upright one of waking life. They must, as it were, bring the line of their spine into the same direction as the animal's. One might investigate a thing like this in greater detail. For instance, it is a physiological fact that there are people who in conditions of illness cannot sleep properly when horizontal but have to sit more upright. Precisely these deviations from the normal association of sleep with the horizontal posture will help to indicate the underlying law. A careful study of these exceptions — due as they are to more or less palpable diseases (as in the case of asthmatic subjects for example) — will be indicative of the true laws in the domain. Taking the facts together, you can quite truly put it in this way: To go to sleep, man must adopt a position whereby his life is enabled in some respects to take a similar course, while he is sleeping, to that of animal life. You will find further confirmation in a careful study of those animals whose spinal axis is not exactly parallel to the Earth's surface.

Here again I can only give you guiding lines. For the most part, these things have not been studied in detail; the facts have not been looked at in this manner, or not exhaustively. I know they have never been gone into thoroughly. The necessary researches have not been undertaken.

And now another thing: You know that what is trivially called “fatigue” represents a highly complex sequence of events. It can come about by our moving deliberately. When we move deliberately, we move our centre of gravity in a direction paralleled to the surface of the Earth. In a sense, we move about a surface parallel to the Earth's surface. The process which accompanies our outward and deliberate movements takes its course in such a surface. Now here again we can discover what belongs together. On the one hand we have our movement and mobility parallel to the surface of the earth, and our fatigue, — becoming tired. Now we go further in our line of thought. This movement parallel to the surface of the Earth, finding its symptomatic expression in fatigue, involves a metabolic process — an expenditure of metabolism. Underlying the horizontal movement there is therefore a recognizable inner process in the human body.

Now the human being is so constituted that he cannot well do without such movement — including all the concomitant phenomena, the metabolic expenditure of substance and so on. He needs all this for bodily well-being. If you're a postman, your calling sees to it that you move about horizontally; if you are not a postman you take a walk. Hence the relationship, highly significant for Economics, between the use and value of that mobility of man which enters into economic life and that which stays outside it — as in athletics, games and the like. Physiological and economic aspects meet in reality. In my critique of the economic concept of Labour, you may remember I have often mentioned this. It is at this point that the relation emerges between a purely social science and the science of physiology, nor can we truly study economics if we disregard it. For us however at the present

moment, the important thing is to observe this parallelism of movement in a horizontal surface with a certain kind of metabolic process.

Now the same metabolic process can also be looked for along another line. We think once more of the alternation of sleeping and waking. But there is this essential difference. The metabolic transformation, when it takes place with our deliberate movements, makes itself felt at once as an external process, even apart from what goes on inside the human being. If I may put it so, something is then going on, for which the surface of the human body is no exclusive frontier. Substance is being transformed, yet so that the transformation takes place as it were in the absolute; the importance of it is not only for the inside of man's body. (The world "absolute" must of course again be taken relatively!)

That we get tired is, as I said, a symptomatic concomitant of movement and of the metabolic process it involves. Yet we also get tired if we have only lived the life-long day while doing nothing. Therefore the same entities which are at work when we move about with a will, are also at work in the human being in his daily life simply by virtue of his internal organization. The metabolic transformation must also be taking place when we just get tired, without our bringing it about by any deliberate action.

We put ourselves into the horizontal posture so as to bring about the same metabolism which takes place when we are not acting deliberately, — which takes place simply with the lapse of time, if I may so express it. We put ourselves into the horizontal posture during sleep, so that in this horizontal position our body may be able to carry out what it also carries out when we are moving deliberately in waking life. You see from this that the horizontal position as such is of great significance. It is not a matter of indifference, whether or not we get into this position. To let our inner organism carry out a certain process without our doing anything to the purpose, we must bring ourselves into the horizontal position in which there happens in our body something that also happens when we are moving by our deliberate will.

A movement must therefore be going on in our body, which we do not bring about by our deliberate will. A movement which we do not bring about by our deliberate will must be of significance for our body. Try to observe and interpret the given facts and you will come to the following conclusion, although again — for lack of time — in saying this I must leave out many connecting links. Human movement, as we said just now, involves an absolute metabolic process or change of substance, so that what then goes on in our metabolism has, so to speak, real chemical or physical significance, for which the limits of our skin are in some sense non-existent; — so that the human being in this process belongs to the whole Cosmos. And now the very same metabolic change of substance is brought about in sleep, only that then its significance remains inside the human body. The change of substance that takes place in our deliberate movement takes place also in our sleep, but the outcome of it is then carried from one part of our body to another. During sleep, in effect, we are supplying our own head. We are then carrying out or rather, letting the inside of our body carry out for us — a metabolic process of transformation for which the human skin is an effective frontier. The transmutation so takes place that the final process to which it leads has its significance within the bodily organization of man.

Once more then, we may truly say: We move of our own will, and a metabolic process (a transformation of substance) is taking place. We let the Cosmos move us; a transformation of substance is taking place once more. But the latter process goes on in such a way that the outcome of it — which in the former metabolic process takes its course, so to speak, in the external world — turns inward to make itself felt as such within the human head. It turns back and does not go flowing outward and away. Yet to enable it to turn back, nay to enable it to be there at all, we have to bring ourselves into the horizontal posture. We must therefore study the connection between those processes in the human body that take place when we move deliberately and those that take place when we are sleeping. And from the very fact that we are obliged to do this at a certain stage of our present studies, you may divine how much is implied when in the general Anthroposophical lectures I emphasize — as indeed I must do, time and gain, — that our life of will, bound as it is to our metabolism, is to our life of thought and indeation even as sleeping is to waking.

In the unfolding of our will, as I have said again and again, we are always asleep. Here now you have the more exact determination of it. Moving of his own will and in a horizontal surface, man does precisely the same as in sleep. He sleeps by virtue of his will. Sleep, and deliberate or wilful movement, are in this relation. When we are sleeping in the horizontal posture, only the outcome is different. Namely, what scatters and is dispersed in the external world when we are moving deliberately, is received and assimilated, made further use of, by our own head-organisation when we are asleep.

We have then these two processes, clearly to be distinguished from one another: — the outward dispersal of the metabolic process when we move about deliberately in day-waking life, and the inward assimilation of the metabolic process by all that happens in our head when we are sleeping. And if we now relate this to the animal kingdom, we may divine how much it signifies that the animal spends its whole life in the horizontal posture. This turning-inward of the metabolism to provide the head must be quite different in the animal. Also deliberate movement must be quite different in the animal from what it is in man.

This is the kind of thing so much neglected in the Science of today. They only speak of what presents itself externally, failing to see that the same external process may stand for something different in the one creature and in the other. For example — quite apart now from any religious implication — man dies and the animal dies. It does not follow that this is psychologically the same in either case. A scientist who takes it to be the same and bases his research on this assumption is like a man who would pick up a razor and declare: This is a kind of knife, therefore the same function as any other knife; so I will use it to cut my dumpling. Put on this simple level, you may answer: No-one would be so silly. Yet have a care, for this is just what happens in the most advanced researches.

This then is what we are led to see. In our deliberate movements we have a process finding its characteristic expression in curves that run parallel to the surface of the Earth; we cannot but make curves of this direction. What have we taken as fundamental now, in this whole line of thought? We began with an inner process which takes its course in man. In sleep this is the given thing, yet on the other hand we ourselves bring a like process about by our own action. Through what we do ourselves, we can therefore define the other. The possibility is given, logically. What is done to our bodily nature from out of cosmic space when are sleeping, this we can treat as the thing to be defined, — the nature of which we seek to know. And we can use as the defining concept what we ourselves do in the outer world — what is therefore well-known to as to its spatial relations. This is the kind of thing we have to look for altogether, in scientific method: Not to define phenomena by means of abstract concepts, but to define phenomena by means of other phenomena. Of course it presupposes that we do really understand the phenomena in question, for only then can we define them by one-another. This characteristic of Anthroposophical scientific endeavour. It seeks to reach a true Phenomenalism, — to explain phenomena by phenomena instead of making abstract concepts to explain them. Nor does it want a mere blunt description of phenomena, leaving them just as they are in the chance distributions of empirical fact and circumstance, where they may long be standing side by side without explaining one-another.

I may digress a moment at this point, to indicate the far-reaching possibilities of this "phenomenological" direction in research. The empirical data are at hand, for us to reach the right idea. There is enough and to spare to empirical data. What we are lacking in is quite another thing, namely the power to synthesize them, — in other words, to explain one phenomenon by another. Once more, we have to understand the phenomena before w can explain them by each other. Hence we must first have the will to proceed as we are now trying to do, — to learn to penetrate the phenomenon before us. This is so often neglected. In our Research Institute we shall not want to go on experimenting in the first place with the old ways and methods, which have produced enough and to spare of empirical data. (I speak here not from the point of view of technical applications but of the inner synthesis which is needed.) There is no call for us to go on experimenting in the old ways. As I said in the lectures on Heat last winter, we have to arrange experiments in quite new ways. We need

not only the usual instruments from the optical instrument makers; we must devise our own, so as to get quite different kinds of experiments, in which phenomen a are so presented that the one sheds light on the other. Hence we shall have to work from the bottom upward. If we do so, we shall find an abundance of material for fresh enlightenment. With the existing instruments our contemporaries can do all that is necessary; they have acquired admirable skill in using them in their one-sided way. We need experiments along new lines, as you must see, for with the old kind of experiment we should never get beyond certain limits. Nor on the other hand will it do for us merely to take our start from the old results and then indulge in speculation. Again and again we need fresh experimental results, to bring us back to the facts when we have gone too far afield. We must be always ready to find ways of means, when we have reached a certain point in our experimental researches, not just to go on theorising but to pass on to some fresh observation which will help elucidate the former one. Otherwise we shall not get beyond certain limits, transient though they are, in the development of Science.

I will here draw attention to one such limit, which, though not felt to be insurmountable by our contemporaries, will in fact only be surmounted when fresh kinds of experiment are made. I mean the problem of the constitution of the Sun. Careful and conscientious observations have of course been made by all the scientific methods hitherto available, and with this outcome: First they distinguish the inner most part of the Sun; what it is, is quite unclear to them. They call it the solar nucleus, but none can tell us what it is; the methods of research do not reach thus far. To say this is no unfriendly criticism; everyone admits it. They then suppose the Sun's nucleus to be surrounded by the so-called photo-sphere, the atmosphere, the chromosphere and the corona. From the photosphere onward they begin to have definite ideas abut it. Thus they are able to form some idea about the atmosphere, the chromosphere. Suppose for instance that they are trying to imagine how Sun-spots arise. Incidentally, this strange phenomenon does not happen quite at random; it shows a certain rhythm, with maxima and minima in periods of about eleven years. Examine the Sun-spot phenomena, and you will find they must in some way be related to processes that take place outside the actual body of the Sun. In trying to imagine what these processes are like, our scientists are apt to speak of explosions or analogous conditions. The point is that when thinking in this way they always take their start from premisses derived from the earthly field. Indeed, this is almost bound to be so if one has not first made the effort to widen out one's range of concepts, — as we did for instance when we imagined curves going out of space. If one has not done something of this kind for one' s own inner training, one has no other possibility than to interpret on the analogy of earthly conditions such observations as are available of a celestial body that is far beyond this earthly world.

Nay, what could be more natural — with the existing range of thought — than to imagine the processes of the solar life analogous to the terrestial, but for the obvious modifications. Yet in so doing one soon encounters almost insuperable obstacles. That which is commonly thought of as the physical constitution of the Sun can never really be understood with the ideas we derive from earthly life. We must of course begin with the results of simple observation, which are indeed eloquent up to a point; then however we must try to penetrate them with ideas that are true to their real nature. And in this effort we shall have to come to terms with a principle which I may characterize as follows.

It is so, is it not? Given some outer fact or distribution which we are able thoroughly to illumina with a truth of pre Geometry we say to ourselves: how well it fits: we build it up purely by geometrical thinking and now the outer reality accords with it. It hinges-in, so to speak. We feel more at one with outer reality when we thus find again and recognize what we ourselves first constructed, (yet the delight of it should not be carried too far. Somehow or other, one must admit, it always “hinges-in” even for those theorists who get a little unhinged themselves in the process: They too are always finding the ideas they first developed in their mind in excellent agreement with the external reality. The principle is valid, none the less.)

The following attempt must now be made. We may begin by imagining some process that takes place in earthly life. We follow the direction of it outward from some central point. It takes its course therefore in a radial direction. It may be a kind of outbreak, such for example as a volcanic eruption, or

the tendency of deformation in an earthquake or the like. We follow such a process upon Earth in the direction of a line that goes outward from the given centre. And now in contrast to this you may conceive the inside of the Sun, as we are want to call it, to be of such a nature that its phenomena are not thrust outward from the centre, but on the contrary; they take their course from the corona inward, via the chromosphere, atmosphere and photosphere, — not from within outward therefore, but from without inward. You are to conceive , once more, — if this (Fig. 2) is the photosphere, this the atmosphere, this the chromosphere and this the corona, — that the processes go inward and, so to speak, gradually lose themselves towards the central point to which they tend just as phenomena that issue from the Earth lose themselves outward in expanding spheres, into the wide expanse. You will thus gain a mental picture which will enable you to bring some kind of synthesis and order into the empirical results. Speaking more concretely, you would have to say: If causes on the Earth are such as to bring about the upward outbreak for example of an active crater, the cause on the Sun will be such that if there is anything analogous to such an outbreak, it will happen from without inward. The whole nature of the phenomenon holds it together in quite another way. While on the Earth it tends apart, dispersing far and wide, here this will tend together, striving towards the centre.

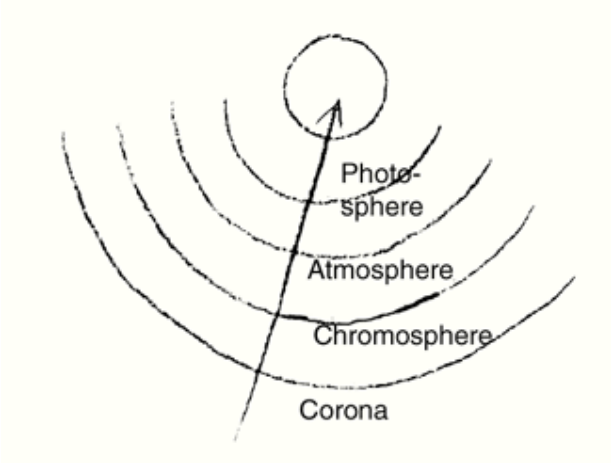

Figure 2

You see, then what is necessary. First you must penetrate the phenomena and understand them truly. Only then can you explain them by one-another. And only when we enter thus into the qualitative aspect, — only when we are prepared, in the widest sense of the word, to unfold a kind of qualitative mathematics, — shall we make essential progress. Of this we shall speak more tomorrow. Here I should only like to add that there is a possibility, notably for pure mathematicians, to find the transition to a qualitative mathematics. Indeed this possibility is there in a high degree, especially in our time. We need only consider Analytical Geometry, with all its manifold results, in relation to Synthetic Geometry — to the real inner experience of Projective Geometry. True, this will only give us the beginning, but it is a very, very good beginning. You will be able to confirm this if you once begin along this pathway, — if for example you really enter into the thought and make it clear to yourself that a line has not two infinitely distinct points (one in the one and one in the opposite direction) but only one, — fact of which there is no doubt. You will then find truer and more realistic concepts in this field, and from this starting-point you will find your way into a qualitative form of mathematics.

This will enable you to conceive the polarities of Nature no longer merely in the sense of outwardly opposite directions, where all the time the inner quality would be the same; whereas in fact the inner quality, the inner sense and direction, is not the same. The phenomena at the anode and the cathode for example have not the same inner direction; an inherent difference underlies them, and to discover what the difference is, we must take this pathway. We must not allow ourselves to think of a real line as though it had two ends. We should be clear in our mind that a real line in its totality must be conceived not with two ends but with one. Simple by virtue of the real conditions, the other end goes on into a

continuation, which must be somewhere. Please do not underestimate the scope and bearing of these lines of thought. For they lead deep into many a riddle of Nature, which, when approached without such preparation, will after all only be taken in such a way that our thoughts remain outside the phenomena and fail to penetrate.

Lecture XVII
Stuttgart, January 17, 1921

My Dear Friends,

May I first refer to a matter from which misunderstandings might arise in future if some of you are thinking further along the lines we have been indicating.[1]

This is essential: You must imagine the plane in which I am drawing the Lemniscate (Fig. 1) to be rotating about the Lemniscate axis, ie. about the line joining the two foci, — call it what you will. I should therefore have to draw the Lemniscate in space. This (Fig. 1) is the projection of it. Such is the drawing of the Lemniscate which you must have in mind with regard to all that I have been saying, — so for example when you are tracing the bony system or the nervous system in man. Even the blood-circulation can be traced in this way. You must imagine it all, not in a plane but in space. The figure eight — the Lemniscate — is therefore legitimate, but as I said before, you are really dealing with geometrical figures of rotation. This also underlies what I have just been saying. The forms of our inner organisation, in the nerves-and-senses system and in the metabolic and limb-system respectively, are mutually related upon the principle of a lemniscate of rotation.

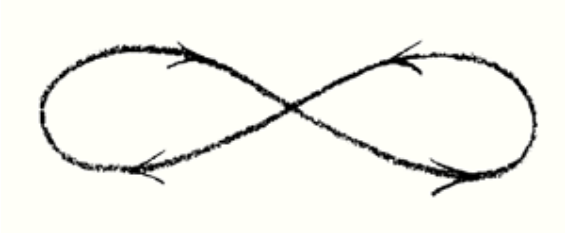

Figure 1

We were obliged to seek the criterion of the true spatial movements of our Earth in changes that go on in man himself. We human beings are, after all, in some way spatially united with the Earth. So long as we merely look at the movements from outside, — then, as I said before, we never get beyond the relativity of movements. If we ourselves however are taking part in the movements and by so doing we perceive internal changes in the moving body, then in these inner changes we can, as it were, read the movements and know them to be real. This is the thing that matters.

We pointed out that in the processes of human metabolism we have an inner criterion of man's deliberate movement, wherein he may be said to move his centre of gravity parallel to the surface of the Earth. Then there are processes very similar to these metabolic processes, which accompany our deliberate movements. They give us a criterion of a true movement which we undoubtedly describe in cosmic space together with the Earth. I referred to the phenomena of fatigue occurring in the course of the day, — i.e. while the Sun changes its position in the heavens. We may formulate it thus: — That which takes place between the head and the rest of man in a vertical direction when man is upright, takes place in a direction parallel to the surface of the Earth — that is, in the direction characteristics of the animal spine — when man is sleeping. Comparing human metabolism in sleeping and in waking respectively, we have indeed a kind of reagent for the relations of movement of Sun and Earth.

Thence we can now pass on to the other kingdoms of Nature. We see the plant, maintaining a radial direction, — the same direction we human beings have in waking life. We must be clear however, when comparing our own vertical direction with that of plant growth, that it is not permissible to think of them with the same sign. We must give opposite signs to the two. Many are the compelling reasons for us to do this: to give to man's vertical direction the opposite sign to that of plant growth. I will refer only to one such reason, mentioned before. The process of plant growth, culminating as it does in the organic deposition of carbon, is so to speak cancelled-out in man: It must, as it were, be negatived.

The very thing the plant consolidates into itself, man must get rid of. This and other considerations will oblige us, if we put the direction of plant-growth from year to year, so long as we are growing. It represents therefore, a process in us, similar to that in the plant. Hence, my dear Friends, we only find our way alright if we think thus: The plant grows radially upward from the Earth, up onto cosmic space. Ourselves we must imagine in a different way. There is our physically visible growth, but we must think of something super-physical, invisible, growing down to meet it — growing into us as it were, from above downward. Herein we have to seek an understanding of the human form, — its vertical direction. We must imagine that while man no doubt grows upward, a kind of invisible plant-formation grows down to meet him. It is a plant-form with its roots unfolding up towards the head and its flowers downward. It is a negative plant-forming process, opposite to the man-forming process. In this sense we must recognize, which movements are alike in kind. As the plant grows away from the Earth, so have we to imagine this super-physical man-plant growing in from cosmic space, even from the Sun, towards the centre of the Earth. This then is what we have. (I say again, I can only indicate general directions: you will be able to follow them up in the light of empirical phenomena) In what we here see (Fig. 2) as a line of like direction — a line of growth, but in the one case striving positively outward, in the other negatively back and downward — in this we have to seek the connecting line of Earth and Sun. You cannot think of it in any other way. Nay, to imagine it thus is comparatively simple, even trivial. You will perceive in this very line the line of movement both of Earth and Sun. The lines of movement both of Earth and Sun are to be looked for in the line that joins the two. Moreover, the line will always prove to be vertical in relation to the surface of the Earth.

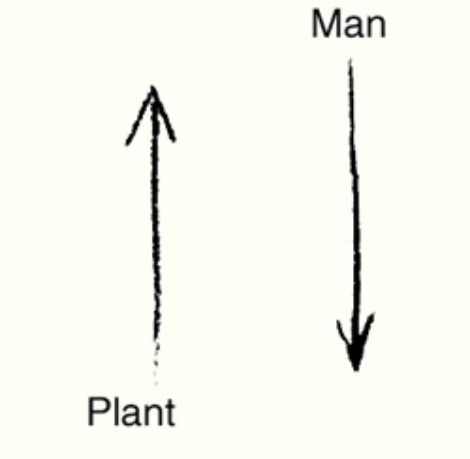

Figure 2

What I have here been putting forward ought really to be the theme of many lectures. I do however still want to give you something more substantial as it were, for you to get to grips with. I want to lead you to a more tangible result, though it will have to follow rather abruptly on the more methodical reflections we have hitherto pursued.

We have been led to realize that Earth and Sun must be thought of as moving in a certain sense in the identical orbit and yet again in a way opposite to one another. You will get a more substantial line of what this means if you recall what was said yesterday. The constitution of the Sun, I said, — with the Sun's nucleus and then the photosphere, atmosphere, chromosphere and corona — can be imagined in no other way than this: While on the Earth craters are formed by outward thrusts and movements, and we think therefore of processes that work from within outward (fundamentally the same is true even of the tides); in the Sun on the contrary we have to go from without inward. The Sun releases its streams and currents from the surrounding periphery inward to the interior, to the solar nucleus. In a sense therefore, we see what is going on the Sun's environment as we should see things going on Earth if we were situated in the Earth's centre and looking outward, — only we should then have bank the convex into the concave. Looking into the Sun, it is as though we should be witnessing earthly processes from the Earth's centre; only for this comparison the Earth's inner surface which is concave

must be bent convex, so that the interior of the Earth becomes the exterior of the Sun. Taking your start from this idea you will be able to realize the polar-opposite character of Earth and Sun. This too is most important: to realize how the Sun' s constitution derives from the Earth's once more by a turning inside-out, — by the same process I explained for the relation of the human metabolic and limb-system with the skull-bone. The coordination of Man and the Cosmos is the more thoroughly revealed. The polarity in man is in its inner quality and process like the polarity of Sun and Earth.

I shall now pursue a line of thought which may look problematical to some of you, yet you would feel it to be thoroughly sound if we had time to go into all the connecting links. However as I said just now, I want to give you something more substantial. We have to look for a curve which makes it possible or us to imagine the movements of Sun and Earth taking their course in one and the same path and yet in some sense contrariwise. The curve can be determined, unambiguously. If you envisage all the relevant geometrical positions which are to be found in this way, the curve, I say again, will be uniquely determined. You must imagine it like this (Fig. 3), — a rotating lemniscate which at the same time moves on through space, resulting in a lemniscatory screw of spiral (as indicated in the Figure). Imagine the Earth to be at some point of this curve and the Sun at another, with the Earth following the Sun in movement. So then you have the movement of the Earth up here, the Sun down here. They go past each other. Taking all the valid criteria into account, this is the only way to conceive the real underlying movements both of the Earth and of the Sun. There is no other alternative than to imagine it arising on this basis: Earth and Sun are moving, following one another, along a lemniscatory spiral; what is projected into space arises out of this. Here is the line of sight (ES, Fig. 3). You are projecting the Sun in this position (S); thereafter, you may assume, the Sun has gone up here (S1). You get the apparent position, including all the relevant and necessary factors, simply as the resulting projection when Earth and Sun move past each other along this line. But I repeat, you must include the manifold corrections, — the Bessel equations and so on, — if you expect your calculation to come true. You must include in the geometrical loci all that is really given. So too you must take into account what I mentioned before, how the Astronomy of today uses three Suns in its calculations: the real Sun, the Dynamical Mean Sun and the Astronomical Mean Sun. Two of them are of course imaginary; only the real Sun is actually there. For our determination of Time however, we reckon first with the Dynamical Mean Sun which coincides with the true Sun at perigee and apogee and no-where else. And then we have the third Sun which only coincides with the other at the equinoxes. You only need correct, according to all this, the accepted notion of the Sun's apparent path. Take all of this together and work it out; then you will certainly get this result, — in full agreement with what we also found observing Man's relation to the Cosmos.

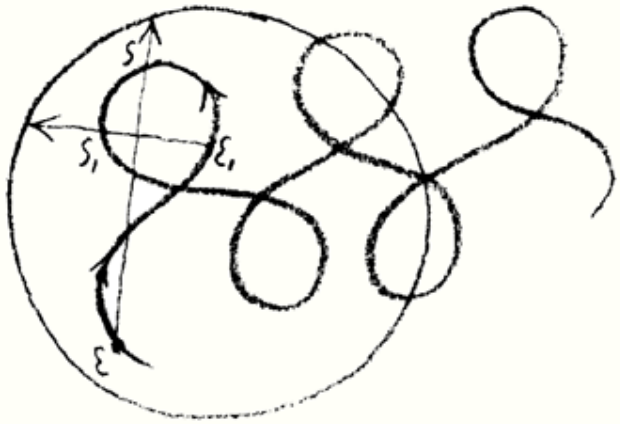

Figure 3

We now need to relate this curve in the right way to our solar system. I will begin by drawing the ordinary hypothetical form of solar system (Fig. 4), omitting the two outermost planets for today, for they are not essential in this connection.

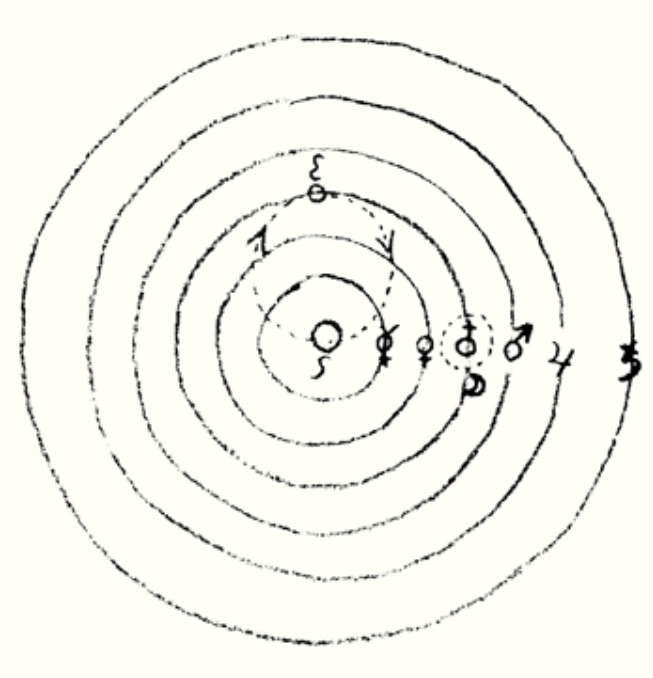

Figure 4

Here (disregarding the relative measures) are the orbit of Saturn, the orbit of Jupiter, the orbit of Mars, the orbit of the Earth with the Moon, the orbit of Venus, the orbit of the Earth with the Moon, the orbit of Venus, the orbit of Mercury, and the Sun. Somewhere along these orbits we should then find the respective planets. Let us assume to begin with what this is a valid perspective from some aspect or other. The question then is how the path of Sun and Earth as we have now described it fits in with this picture. Work out the calculation in the way indicated and you will find that it fits in as follows. We have to draw the path of the Earth with the Earth tending in a sense, towards the place where the Sun has been, and then again the Sun towards the place where the Earth has been. We thus get the one self of the Lemniscate — Earth, Sun, Earth, Sun. When this has been gone round, then it goes on (Fig. 5). They move past each other, as you see.

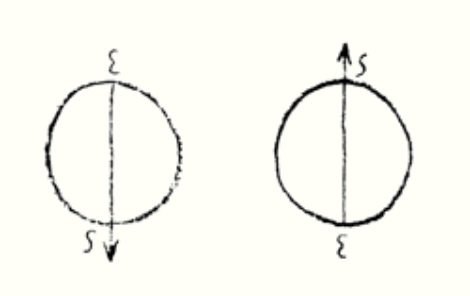

Figure 5

Thus we obtain the true path of Earth and Sun if we alternately imagine the Earth to be at the place where in our usual drawings we are wont to put the Sun, and the Sun at the place where we are wont to put the Earth. The fact is, we do not get the true relation of movement as between Earth and Sun if we assume either the one or the other to be at rest. We must imagine both to be in movement, whereby the one follows the other, yet at the same time they go past each other. So then we have to picture it. Seen

in perspective, the Sun is alternately in the middle point of our planetary system and then again the Earth is where we normally conceive the Sun to be. They change places, taking turns as it were. But it is complicated, for in the meantime the planets too, needless to say, have changed their situation, which brings in no little complication. However, if I take this, to begin with, to be a true perspective, I shall draw it thus (Sun in the middle point). Then as it were I get the other valid order by drawing the ideal sequence of the planets with the Earth here (Earth in the centre) and then Moon, Mercury, Venus, Sun Mars, Jupiter and Saturn. You see, we are in a way misled by the perspective's, to the establishment of an extremely simple system, whereas in fact it is by no means simple. It is as though, with respect to the planets, Earth and Sun were taking turns, alternately being in the centre of the system.

I confess it is not at all easy for me to be telling you these things, which at the present stage might still be thought fantastic. We cannot not now bring all the mathematical paraphernalia to bear on them, but I assure you they can be calculated in all detail. The desire was for me to explain the relations of Astronomy to other branches of Science; hence at the end of these lectures I must try to give a resume as clear and as complete as possible.

Tracing the path of Earth and Sun (now, once again, apart from the planetary system as a whole) we have then to imagine a Lemniscate in which the Earth is following the Sun. Here is it, projected (Fig. 6). Incidentally, you may also see in this a possibility of giving meaning to the idea of Gravitation. The one draws the other after it: that is the underlying principle. Think of it in this way, and you will no longer need the somewhat questionable quality of gravitational and tangential forces, for they are here reduced to a single force. Think it through thoroughly and you will find it so. You must admit, it is a rather problematical feature in the Newtonian conception. We are to think of the Sun in the centre and the Planets around it — endowed, one and all, with a kind of "shove" in the tangential direction, one and all, without presupposing which the Newtonian system would break down.

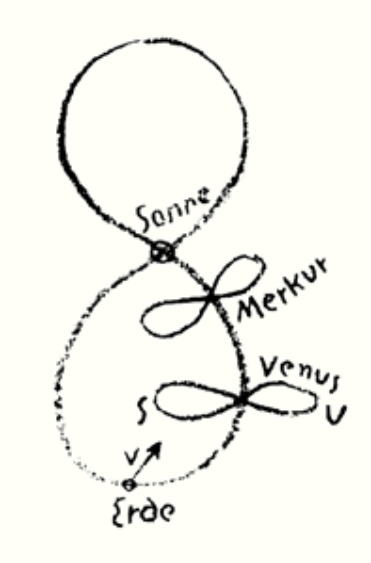

Figure 6

Taking this then (Fig. 5) to be the path of Earth and Sun, — if you wish to bring out in perspective, along with the course of Earth and Sun, the path-forms of the other planets, you must imagine the paths of the inferior planets somewhat in this way (small Lemniscates in Figure 6). This will enable you — if this be the line of sight — to get the perspective of a planetary loop, for a certain position of the planet along its path. The line of sight is here (v). In this position (s) we get the loop, while these two branches (u) will appear to run out into the infinite. On the other hand, taking this once more to be the path of Earth and Sun and this the path of the inferior planets, you must imagine the corresponding paths of the superior planets to be Lemniscates like this (Fig. 7). I should now have to go on drawing

upward, but the nearest part would be like this. And now this Lemniscate[2] moves on, makes its way through, — through the Lemniscate of the superior planets.

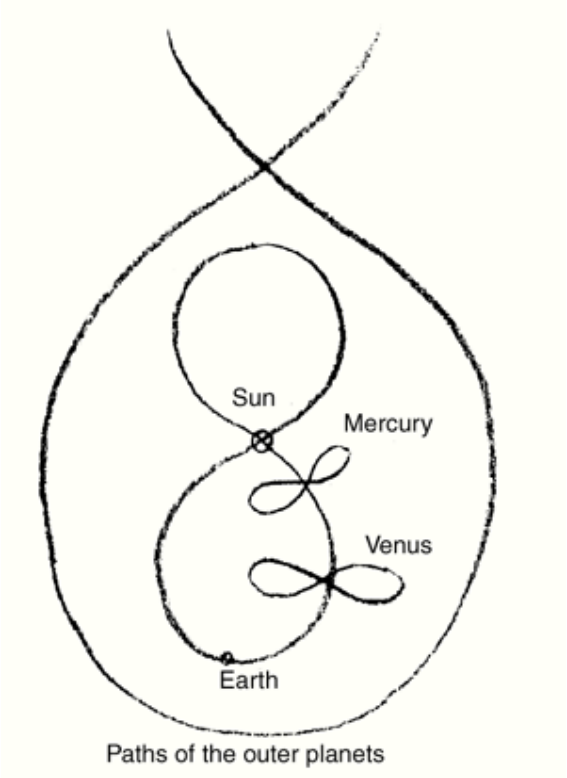

Figure 7

It is a system of Lemniscates in determined order and relation. Such are the paths of the planets; such also is the path of Earth and Sun. Now you will easily harmonise what I have here presented in the grammatic outline, with the fact that we see the loops of Venus and Mercury in conjunction and those of Jupiter, Mars and Saturn in opposition. In our perspective it is the necessary outcome. Above all, you will recognize once more what the connection is between the planes and the human being. You need but look at this picture and you will say to yourselves: What you have here, in Mercury and Venus, is near in direction to the path of Earth and Sun. It is in the cosmic neighbourhood, so to speak, of the path of Earth and Sun. It is therefore in this relation: It has to do with the radial line — fundamentally, the connecting line of Earth and Sun. As against this, the other paths — those of the outer or upper planets — work more by virtue of their lateral or spherical direction. In their effects, they more approach what is peripherical in movement. We may then also formulate it thus: What we behold in Venus and Mercury is far more akin to what is living as a cosmical reality in us ourselves. Whilst, what we see in the paths of the superior planets is more akin to the fixed-star Heavens in general. Here too we reach a kind of qualitative valuation of what is taking place in the Cosmos. Of course the lines I have been drawing are only meant diagrammatically. It should really be put this way: An inferior planet has a path, making a lemniscate loop-curve the centre of which is the Earth-and-Sun path itself. A superior planet, on the other hand, embraces the Earth-and-Sun path in its own lemniscate-loop. Such is the essence of the matter; the thing itself is so complicated that the mental pictures we can form scarcely be more than diagrammatic.

You see from this however, my dear Friends, — unwelcome as the news may be to some, — we need to get away from a principle that crept into the explanations of nature with the beginning of modern time. I mean the overriding principle of simplicity. It grew to be the accepted tendency. The simple explanation is the right one! Even today one is severely censured if one puts forward what is not simple enough. Yet Nature is not simple. On the contrary, it would be true to say: Nature the real

World — is that which, looking simple proves on examination to be complex. What appears simple on the surface, is as a rule only the outward glory, only the outward semblance of it.

It was not by any means my prime intention to let these lectures culminate in this way. I am not predisposed on principle to put forward things out of keeping with the accepted notions. We only want to get at the truth. As it is is however, the assumptions of the modern astronomical world-picture involves so many contradictions that in the end, having studied the current astronomy, one comes away dissatisfied. Hypothetically, it begins by assuming the world-picture I have also indicated in this sketch (Fig. 4), — the elliptic orbits of the planets, the Sun in one focus, and so on. The planetary orbits are then assumed to be in different planes, inclined to one another. For there is no alternative at this stage; the different inclinations are given by the perspective. The complications of it are complications of perspective. Yet the real calculations are not done to the basis of this simple solar system which people have explained to them at school and then retain for life. In practice, they take their start from the Tychonic system. Then one correction after another has to be applied. From the accepted formulae, one calculates, say, the position of the Sun at given time, and it does not come true. Instead of the real Sun being there, it will be the Dynamical of Astronomical Mean Sun, — something fictitious therefore. So it is time and again: Imagined entities are there, and more corrections must be introduced to get to what is real. In these corrections there lies hidden that which would lead to the truth. Instead of holding fast to the conventional formulae and being led to fictitious entities, one should bring movement into the formulae themselves — make them inherently mobile — and then draw curves accordingly. If one did so, one would soon reach the system here drawn, though I repeat, the drawings are diagrammatic.

What I have sought for above all is that a picture should arise in you of the harmony there is between the organisation of Man and the constitution of the Cosmos. If you have really been following thus far, you cannot possibly regard this as offending against the scientific spirit. When the transition emerged from the Ptolemaic to the Copernican World-picture, a profound change was taking place in the whole way of interpreting the connection of man with the celestial phenomenal. In very ancient times — though from a different perspective so to speak, as mentioned a few days ago — man still had clear and penetrating ideas of the harmony between the movements in the Heavens and the form of Man. What they then had was more instinctive; raised into consciousness however, it becomes the true spirit of modern science, to which we too must be faithful, — the more so when venturing upon this problematic ground.

Fundamentally there is no difference between the way of applying mathematics in general and the way we are applying this qualitative mathematic (which we have first had to develop) to man and the celestial phenomena. There is another thing however, you need to recognise in this connection. In the same period when the transition was developing between the old heliocentric system and the new heliocentric, the evolution of mankind suffered a certain break in the life of knowledge, Namely the bridges were demolished between the physically sense-perceptible or natural world-order and the ethical or moral. I have often mentioned in other lectures, how we in our time are thus torn asunder. On the one hand our theoretical ideas about Nature lead us to conceive some primeval cosmic entity in the beginning, from which the Universe was to unfold by purely natural events. So then evolved the Earth on which we are. So it goes on again by dint of purely natural laws and it will one day reach its end. In the midst of it are we. Out of our inner life there arise ethical impulses; no-one knows where they come from. And if one thinks according to this dualism, one cannot doubt that at some future time even these impulses will suffer burial in the universal grave.

This is the way one thinks when failing to build a bridge between the natural world-order and the ethical. I have indicated on other occasions how the transition is to be looked for. It can indeed be found throughout Anthroposophical spiritual science. Here I would only draw your attention to a specific aspect of it, — for the rift between the natural world-order and the moral makes itself felt in diverse realms, and among others it affects our present subject. Here too, in the evolution of mankind the natural aspect and the ethical have in a certain way fallen asunder. The ethical has been cultivated in Astrology; the natural in an Astronomy bereft of spiritual values. There is no need for me to insist

that Astrology as pursued today is scientifically unacceptable. I need not prove to you that this is an aberration on the one side. Yet on the other side our Astronomical world-system, as we call it, also involves an abberaction. All these perspective lines — or if you will, projective lines — that are conventionally drawn to represent our solar system, are not to be conceived as realities at all. Nor even are the lines that arise when we observe a further resultant movement, built up again of many components, namely the Sun's proper movement, the whole solar system going with it. All these things are built up of very many components; we are in the midst of relativities and we need some criterion to hold to. The criterion may seem vague to many people, yet it is there and it can lead us to an understanding of the curves in question. We have to penetrate the secret: Why is it man has an inner need to lie down horizontally in sleep, — thus to escape in sleep from the connecting line of Earth and Sun? Just as he can only carry out his voluntary movements while moving his centre of gravity at right angles to the line joining Earth and Sun, so with his involuntary movements: He can only carry them out by lying down, putting himself in a direction at right angles to the path of Earth and Sun. If he wants to escape from the effects of voluntary movement — if he wants, what would otherwise work itself out in voluntary movement, to work inside him and bring about a metabolic interchange between his body and his head — he must lie down, he must align himself in this way. In like manner you will be able to find other directions that are at work in man.

From the directions ascertainable in man — derivable from man's own form and stature — you will be able to compose the curves that are really there in the movement of heavenly bodies. Granted, it is not so easy as what is done with mere telescopes and measured angles. Yet it is the way, the only way, to find the relationship between the human being and the celestial phenomena.

Notes:

1. The beginning of this lecture arose out of a mistaken remark by one of those present, which is omitted. Dr. Steiner's explanations, important for a general understanding of the lemniscatory curves, are reproduced apart from this.

2. Namely the lemniscate of Sun and Earth.

Lecture XVIII
Stuttgart, January 18, 1921

My Dear Friends,

If we recall what I said yesterday about the opposite character of Earth and Sun, we shall perceive that in answering such questions it is all-important to follow up the empirical facts in the right way. We cannot form true ideas of what we see if we do not recognize from the outset that radical differences may be called for in the whole way we interpret what is seen in one case and in another. The phenomena that present themselves to us when looking at the so-called body of the Sun will only find their true interpretation if we start from such premises as we were indicating, for example, when we put this question: —

On Earth there are many phenomena the characteristic of which is that they work outward from the given center to the wide circumference, — out into cosmic space We interpret them accordingly. How must we then interpret similar phenomena — or rather, phenomena that seem superficially similar — when we are looking, with or with-out the help of optical instruments, towards the Sun? Truth is, the empirically observed phenomena will only reveal themselves in their true light if we then take our start from some such idea as this: whilst on the surface of the Earth an eruption or the like will naturally be interpreted as tending up and outward (Fig. 1a), a process on the Sun — a Sun-spot for example — must be interpreted rather as tending from without inward (Fig. 1b). Continuing this line of thought: Just as we have to imagine that if we went through and beneath the surface of the Earth we should get into dense matter, so shall we have to imagine that if we moved from outside the Sun towards the Sun's interior we should come into an ever more attenuated state of matter. And we may truly say: Look at the Earth and the whole way it is placed into the Universe. It manifests as so much ponderable matter in the Universe. Not so the Sun. Here we shall only come near the truth if we imagine that as we go from the circumference towards the interior we get ever mere remote from ponderable matter and ever more and more into the imponderable. We have precisely the opposite behavior as we draw near the middle point. The Sun must be conceived as a hollowing-out, shall we say, of cosmic matter, a hollow space, a hollow sphere, — a sphere enveloped by matter, — in contrast to the Earth where we have denser matter enveloped by more attenuated. As to the Earth, we think of air around it. Air is outside and denser matter inside. For the Sun it is the opposite; as we go inward we go from relatively denser matter into more attenuated and at long last into the very negation of matter whoever takes the phenomena with open mind and puts them all together will be obliged to recognize that this is so. The Sun is not only a more attenuated heavenly body, of a materiality less dense than earthly matter, but if we call the Earth's materiality positive, then in the Sun — in the Sun's interior — we shall have negative matter in a certain sense. We only do justice to the phenomena if we conceive that there is negative matter in the inner space of the Sun.

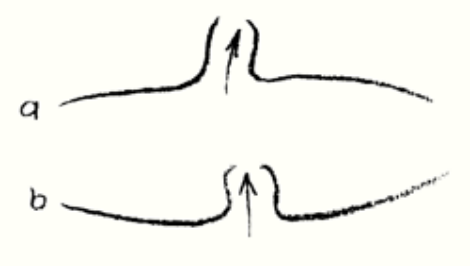

Figure 1

Now, my dear friends, as compared with positive matter negative matter is suctional. Positive matter exerts pressure, negative suction. And if you now conceive the Sun as a collection of suctional force, you need no further explanation of Gravitation. This is the explanation, Now think of it as I explained it yesterday. The movement of Earth and Sun is such that the Earth follows the Sun in the same path, in the same direction. Here then you have the cosmic relation between Sun and Earth. The

Sun as a gathering of suctional forces goes on in front, and by this suctional force the Earth is drawn on after, moving through cosmic space in the same course and in the same direction in which the Sun thrusts forward.

You thus perceive and understand what you would otherwise fall short of in your thinking. In no other way will you reach an adequate idea, to comprise all the phenomena. You have to start from such ideas as these. You must imagine that in the realm of matter there is a positive and a negative intensity. Matter itself, — that is, earthly matter — is positive; it is of positive intensity. Solar matter on the other hand is negative — of negative intensity — and is therefore not only empty in relation to matter-filled space, but even "less than empty". It is a hollowing-out of space itself.

This may be difficult to conceive. Yet if you are accustomed to having mathematical ideas, why should you not think of a certain degree of the fullness of space as a corresponding magnitude, say +a? Empty space would then be Zero, and a space less than empty would be conceivable as -a. This granted, you will be able to conceive a truly mathematical relation — or at least, a relation analogous to mathematical — between the different intensities of matter, as in this instance between terrestrial and solar matter.

As it were in parenthesis I may add the following: No matter how you think of the relation of positive and negative real numbers to imaginary numbers (I will not go into this question now), some interpretation of the so-called imaginary numbers must be discoverable, and since they too emerge in the solution of equations and the like. If in the way we have been saying you recognize a positive and a negative of intensity, you may well conceive that there is also an imaginary [intensity]. You must then have which would enable you to add to positive matter and negative the kind of matter for example (or if you will, the kind of spirituality) which Anthroposophy describes as the Astral. Thus you would find a mathematical way of approach to the Astral too. However, as I said before, this only in parenthesis.

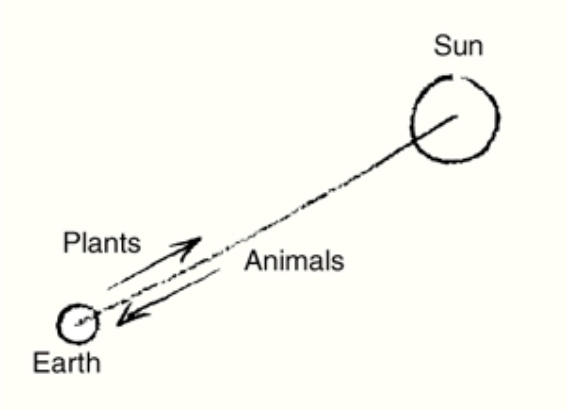

Figure 2

Once again take the connection of what I have been saying with man himself. You will admit: without any doubt the human physical body is related to ponderable earthly matter, and since it is as waking man — upright in his physical body — that man is related to earthly matter, we may compare man's relation to earthly matter with the upright direction of the plant, following what was said in preceding lectures. However, yesterday we saw that the plant must be imagined with the very opposite direction in the human being, while the outer plant must naturally be conceived as growing upwards from below, the plant we have to think of in the human being moves in a manner speaking, from above downward (Fig. 2). What is it then that grows from above downwards? Certainly nothing visible; it must be something invisible. Now we related this to the Sun. It there fore in relating the forces of plant-growth to the path of the Sun and Earth we think of them as tending from the Earth towards the Sun, we must needs think of what grows in the reverse direction in the human being as growing, in effect, in his etheric body. This force of suction therefore, proceeding from the Sun, works

also in the human being. permeating his etheric body from above downward. Upon the human being — the human body in this instance — two opposite entities are at work; Sun-entity, Earth-entity.

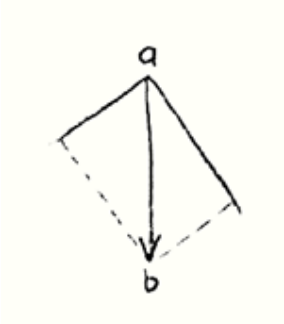

Figure 3

We should be able to prove in detail that these things are there, and we can indeed, once we perceive the true interpretation. This that is working in the human being from above downward may resolve itself in very many ways. For if we have a force, say, in the direction a - b, we can trace it snot only in this direction but also in an imaginary sense. Namely if this (Fig. 3) is its intensity, we need only imagine it resolved into two components. Thus we can every where form components of forces in the direction of the path of Earth and Sun. If I press here with my finger, there will arise over this surface the force or pressure whereby the ponderable matter presses against me. The counter-pressure will then correspond to the force of the Sun that is working through me — through my etheric body, that is to say. Imagine a surface here pressing against the human being, — or against which he is pressing. Here you already have the opposition — the working of the ponderable and of the imponderable able force. It is the interplay of the ponderable pressure from without inward and of the imponderable from within outward (Fig. 4) which gives you the conscious sensation of pressure. If in our mind we see all these things clearly and comprehensively, we may truly say that the polarity of Sun end Earth into the midst of which the human being is placed, is felt by us in every sense-perception. In like manner, everything about the human being can be traced in such a way as to perceive the cosmic realities that are involved. Cosmic forces work into the human being upon every hand.

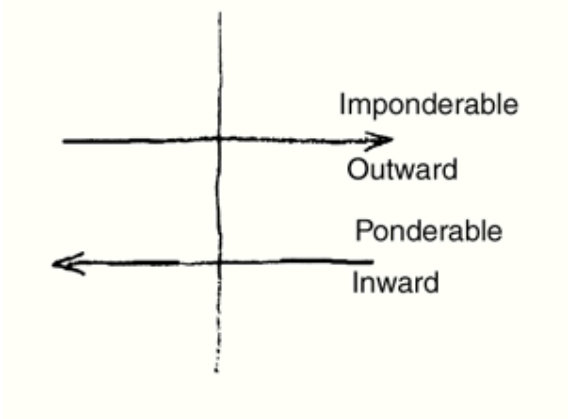

Figure 4

It is of untold importance for us to overcome the method that excludes the human being and that is always haloing fast to isolated things, see it without any connection with their surroundings. You will remember, I used the same comparison before. If we place man into the world in such a way as to study head, limbs, etc., one by one and in a merely outward sense, it is as though we were to study a magnet-needle, tending as it does ever in the same direction, and seek the cause of this behaviour not in the magnetic pole of the Earth but inside the needle. To understand any fact or object, we must go to

the totality from which alone it can be understood. What matters is in every case to look for the totality in question. Precisely this, alas, is foreign to the habitual ways or thought in our time. Before attempting to decide a problem, look first for the totality on which it all depends. You take a crystal of salt into your hand. You may regard it as a totality, just as it is. Even this is only relatively true, but at least relatively you can so regard it. It is, in a sense, a self-contained entity. Not so if you have picked and place a rose before you. Placed there before you in this way, the rose is not a self-contained entity at all. It could not be there in the same way as salt-crystal can. The crystal, it is true, must also have been formed in a surrounding medium; nevertheless it is a totality, the rose can only be looked upon as a totality when seen in connection with the shrub on which it grew. Only there has it the kind or totality which the crystal-cube of salt has on its own. Likewise if we look at man with respect to his full being, we cannot stop short at the limits of his skin, we must regard him in connection with the great universe that is visible to us; only in this connection is he to be understood. Such then must be our method, and as we persevere in it we become able to see a deeper meaning in the phenomenon that present themselves to us, — that can indeed be mastered by our cognition.

During these lectures we haves recalled the fact that in comparing the periods of revolution of the planets incommensurable magnitudes emerge. For if they were commensurable, the planetary paths would presently come into such relation to one another that the whole system would rigidify. Our planetary system does indeed also contain this tendency to become rigid and dead.

We can express what confronts us in the planetary system by means of certain curves — and arithmetical formulae. Yet as we saw, these curves and formulae are never in full agreement with reality. We must therefore admit that if we try to contain the phenomena of the Heavens in succinct formulae or geometrical figures the phenomena elude us. Time and again they elude us. This then is true: — look outward on the one hand and behold the given picture of the celestial phenomena. Look on the other hand at what we are able to make of it by dint of calculation. We never do contrive a formula that coincides entirely with the phenomena. We may devise such a drawing as I was sketching yesterday — the system of lemniscates. We can do so indeed. Even this system however, — we only understand it rightly if we admit the following. Suppose I managed to draw this lemniscatory system in a precise and finished form; it would at most be true of present time. Even a time comparatively near our own — the time I indicated when speaking of the coming ice-age — would require me to modify the system not a little. The constants of the curves must themselves be taken as variable. The very constants would therefore be curves of some complexity by virtue of their variations. Thus I can never draw staple straightforward curves, but only complicated ones. Even when drawing these lemniscate-curves (Fig. 5) I should have to say: Good and well, — I draw a path for some heavenly body. (As we saw yesterday, it will always be a lemniscatory path.) I draw the path. Yet when a certain time has elapsed I must disqualify it; it is no longer valid. I must make the Lemniscate a little broader. And then again after a time I must draw such a Lemniscate (Fig. 5 once more), and so on.

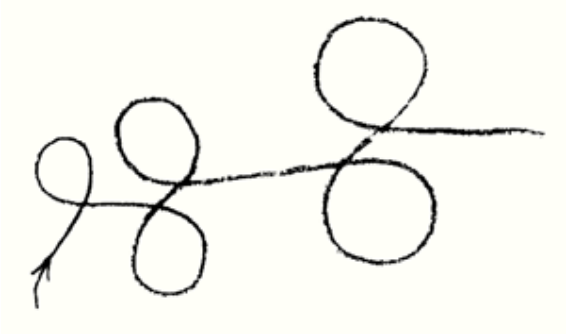

Figure 5

In effect, my dear friends, if I were to trace the paths of the heavenly bodies, I should really have to go out into the Universe and trace them ever anew, varying them all the time. There is no constant path which I may draw. Whatever path I may work out, I must remember in so doing that I ought

really to be changing it all the time, since every lapse of time involves a change of path, however slight. To apprehend the heavenly bodies and their paths of movement in any adequate way, I cannot draw ready-made lines at all. Ready-made lines, if I do draw them, will only be lines of approximation, and I shall have to bring in corrections. Whatever finished lines I may devise, the phenomena in the Heavens will presently elude them, No matter what mathematical curve I may devise, once it is fixed and finished the reality will certainly escape me; my finished curve will not contain it, yet in the very act of saying this, I am giving voice to an important reality. Namely, a planetary system has this essential feature: It tends in both directions, — on one hand towards rigidity and on the other hand to the forming of ever-mobile Lemniscates. In the solar Saturn or planetary system there is this contrast between the tendency to become rigid and the tendency to be ever variable, ever escaping from its established form.

If we now follow up this very contrast, not in the way of speculation but in the actual seeing and contemplating of the phenomena, we shall be led to recognize that what we call a comet, a cometary body, is not a body at all in the same sense that a planet is. (What I am giving her, I give once more as guiding lines which you can verify for yourselves. You need only observe the empirical data. Observe them with the greatest possible precision, but do not cling to the theories with which so many scientists would fetter them — theories that lie like shackles upon the facts, You will convince yourselves: what I am about to say is verifiable. It will be verified increasingly, the more the given facts are put together.)

Truth is that in studying the cometary phenomena we get into difficulties if we conceive the cometary body too in the same way as we are wont to think of a planetary body. The planetary body (I refer again to the same question of principle and method as in an earlier lecture), — the planetary body you may represent as though it were a self-contained body moving on in space. You will not go much against the facts in so conceiving it. Not so a cometary body. Again and again you will find yourself in contradiction to the phenomena if you conceive it after the same pattern as the planetary body. You will never understand the cometary body, in the way it moves — or seems to move — through cosmic space, if you regard it as you are accustomed to regard the planetary body.

See what becomes of it on the other hand it you regard it as I shall now describe. Take all the empirical facts that are available and try to thread them on this line of thought. Imagine that in this direction (Fig. 6) — towards the Sun, as we may say — the comet comes into being at every moment. It is for ever coming into existence in this direction. It pushes towards its cometary nucleus, or what appears as such. Behind, it melts away again. In this way it thrusts forward — for ever coming into being on the one hand, passing away again upon the other. It is not a body in the same sense as a planet is, — not at all. It is perpetually coming into being and passing away again — renewed in front, accruing all the time in this direction; losing the old at its tail. It pushes forward like a mere effulgence, a mere phenomenon of light; but please, I do not say that that is all it is.

Figure 6

And now remember what we were saying a few days ago. There is not merely the Moon up there and the Earth here (Fig. 7), but every planet has a certain sphere, and what we see is only a point at the periphery of the said sphere. The true Moon is the sphere, bounded by the lunar orbit. We, with the Earth, are in the Lunar Sphere. So also, in a certain sense, are we in the Solar Sphere and in the

spheres of all the planets. The planets are not merely what is out there, moving in lemniscates, — what is at yonder point or yonder at any given moment. The visible point is only a specialized part of the whole; it is, as I was saying, like the ares of germination in the germinal vesicle of the human embryo.

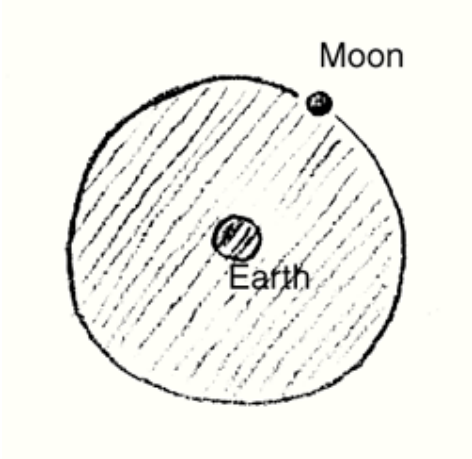

Figure 7

If you remember this, then you will say to yourselves: Here now I have the Earth and the Sun. In fact, two spheres are interpenetrating, thrusting into each other, — spheres which are really due to materialities of opposite tendency and kind. The one comes from the centre of the Sun, towards which negative matter is tending; the other from the centre of the Earth, from which positive matter is raying out. Positive and negative materialities are interpenetrating here. Naturally, the interpenetration will not everywhere be homogeneous. Not even clouds that move through one another would interpenetrate homogeneously. It is essentially inhomogeneous. Imagine how, in this mutual penetration, the different densities will impinge on one another. Then, in the penetration of the one substantiality by the other you have the requisite conditions for such phenomena as comets to arise. Comets are ever-nascent phenomena, perpetually coming into being, passing away again; and if we draw our ideal picture of a planetary system, say the Copernican picture, with the Sun here and Uranus and Saturn here (Fig. 8), we have not to imagine that the comet is arriving there from some great distance and then making its departure.

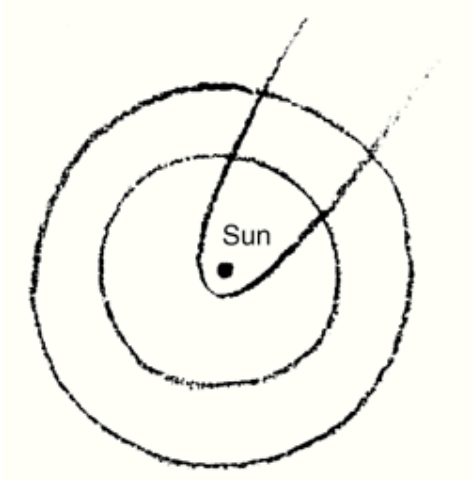

Figure 8

Out there — outside the system — we need not imagine it to exist at all, It is not there to begin with, but becomes; then, at the perihelion, changes the gesture of its form, which is in fact ever-becoming, ever-nascent. Out there at last it melts away again and is no more, The comet comes into being and passes away; that is its very nature. Hence it can sometimes have apparent paths that are not closed at

all — parabolic paths or hyperbolic, — for there is nothing moving round such as would have to move in a closed path. All that there is comes into being, and may well do so in a parabolic direction and then vanish and be no more.

Altogether, we must look upon the comet as a fleeting thing. In relation to Sun and Earth, it is a phenomenon of compensation between ponderable and imponderable matter, — a meeting of the two kinds of matter, which do not immediately balance-out as when light extends in air. For in the latter instance too, there is a meeting of the ponderable and the imponderable; here however they spread continuously, homogeneously as it were, — do not impinge on one another. Take for example air, with light of a certain intensity passing through it. The light spreads homogeneously; but if so be the light does not adapt itself to the air quickly enough, a kind of inner friction will ensue between the ponderable and imponderable matter; only I beg you not to understand this in a mechanical sense but as an inward process (Fig. 9). Follow the comet in its movement. It is a mutual friction of ponderable and imponderable matter that moves on through space. It comes into being at every moment and passes away again.

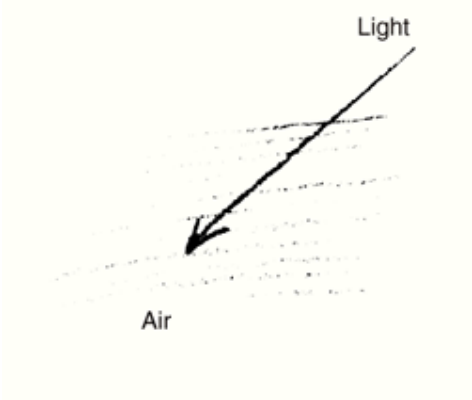

Figure 9

What I have tried to give you in these studies, my dear friends, was meant to bear on scientific method above all. Although the shortness of time has obliged me to deal with some of these things in bare outline, scarcely more than hinting at them, yet if you follow up the thoughts and indications of these lectures you will see that this is what I have been pointing to: It is a transmutation of method, in the whole way of scientific thinking and research. It would be most important for such lectures to become a starting-point for real work. I can only give general directions, as it were; and yet again and again, where we may only seem to have been working with mathematical curves and the like, you will find inspiration for empirical research and experiment. On every hand, both in the coarser and in the finer aspects, you may attempt to verify what has here been presented in seemingly mathematical and geometrical guise. You may take one of those blue or red toy balloons and examine the effect when you forcibly indent it from without inward, where the indentation will of course follow certain laws. See then what form is taken by the same type or phenomenon when in another experiment you make the forces work from within outward radially. Whether, I say, you are examining only this crude phenomenon of stress and deformation or whether you follow the lines along which the heating effect will spread when you heat certain substances — from within outward in one case, from the periphery inward in another, — or again whether you try your hand it optical, magnetic or other phenomena, in every instance you will find that what has here been said about the contrast of Sun and Earth (to mention only this example) can be detected experimentally.

Above all, if such experiments are carried out, you will begin to penetrate the realities quite differently than has been done before. For you will meet with conditions, factual distributions, which have not hitherto been met with, or have been overlooked. From the realms of light and heat and so on, quite other effects will be derivable than hitherto, for the simple reason that the phenomena have not yet been approached in such a way as to become fully manifest.

Such, my dear Friends, are the developments which I would like to have suggested to you. May-be in future lectures, before very long, we can continue and make actual experiments. It will depend on how our physical and other laboratories prosper, — whether you will have reached experimental methods or real value for the future. Let us not pursue the ideal of equipping our new laboratories with the most costly and perfect apparatus from the scientific instrument makers and then experimenting in the same way as other people do. For on these lines they have done splendid work on every hand. What we must do, as I said before, is to devise new kinds of experiment. We should begin therefore, not with a fully equipped Physics Laboratory, but as far as may be with an empty room, which we go into with the thoughts of a new Physics growing in our minds and souls, not with the usual instruments all ready-made. The emptier our laboratories and the fuller our own heads, the better experimenters we shall grow to be in course of time, my dear Friends.

This is what matters most in the present connection, and in this sense we must do justice to the tasks of our time. Think only of the fetters that are cast around you in the different experimental sciences in the normal course of study nowadays; you had no opportunity to see or to set out the phenomena in any other form than was provided for by the accustomed apparatus. With these instruments, how can you expect to study the spectrum in Goethe's sense? You can not possibly. Given these instruments, nothing else can emerge than what you read of in your text books. You cannot even see why we reject the artificial insertion of “light-rays” in the interpretation of the phenomena of light, where in fact, there are no rays at all. We say to ourselves: There is a vessel filled with water (Fig. 10); on the bottom of it lies a coin. The coin seems to be at a different place. We hardly begin to think of this phenomenon, and we have already drawn our diagram with the normal and sundry other lines and rays (Fig. 10). We follow the whole process with such lines, where from the very outset we ought not to be pursuing such an isolated thing at all. Nowhere in reality are we confronted with such isolated things. If this (Fig. 11) is the bottom of the vessel and a coin is lying here, we only begin to see how the coin is to be treated when we think as follows. Imagine on the bottom of the vessel, not an isolated coin, but a circle, for example, made of paper (as in Fig. 12). The phenomenon is, that when seen through a surface of water the paper circle appears lifted and enlargerd. That is the pure phenomenon, — that you can draw. If then at the bottom of the vessel you have not the whole circle but only a little bit of it, you have no right to treat it differently. The coin in effect is like a little fragment of the paper circle. You have not to draw all manner of lines into the picture but to treat it as a portion of the circle, nay of the bottom of the vessel as a whole, — of what is there all the time even if not made visible by differentiation. The mere fact that I have made one point visible at the bottom of the vessel does not justify me theoretically, in treating this visible point as a point by itself. It has not the significance of a point, but only of a part of the larger circle (Fig. 13).

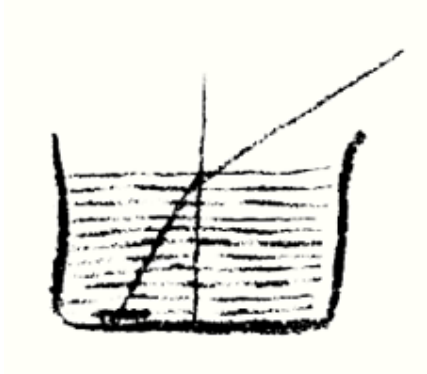

Figure 10

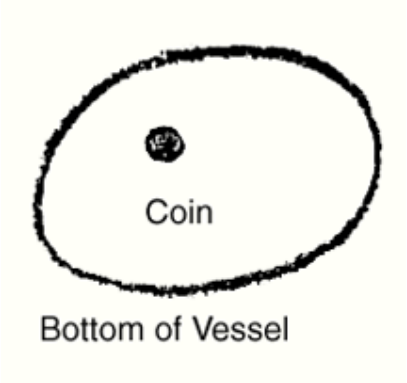

Figure 11

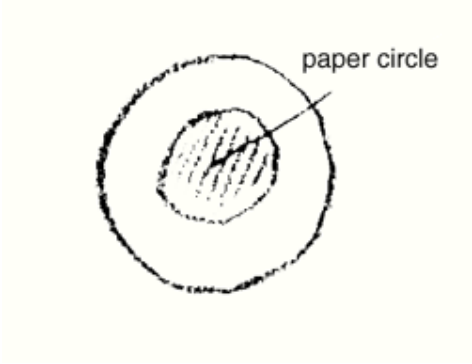

Figure 12

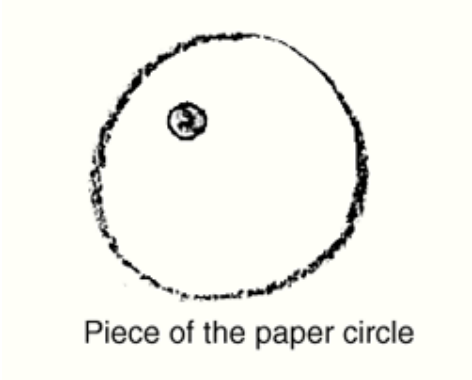

Figure 13

Likewise a magnet-needle: In its reality I may not treat it as though there were a centre here, and here a north pole and a south pole; but I must realize that purely and simply by virtue of this arrangement the whole of it is one unlimited line, with forces working peripherally on the one hand and centrically on the other (Fig. 14). In the electrical phenomena this finds expression in that we set the cathode on the one hand, the anode on the other. On the one hand we can only explain the luminous phenomenon by regarding it at a portion of a sphere, the radius of which is given by the direction in which the electricity is working; whereas the other pole is given as a tiny portion of the radius itself. It Is not justifiable to speak of a simple polarity of poles. We should speak in quite another way. Namely, wherever anode and cathode make their appearance, this will belong to an entire system; purely and simply by virtue of the simple arrangement it belongs to an entire system. Only by speaking in this way shall we attain true understanding of the phenomena.

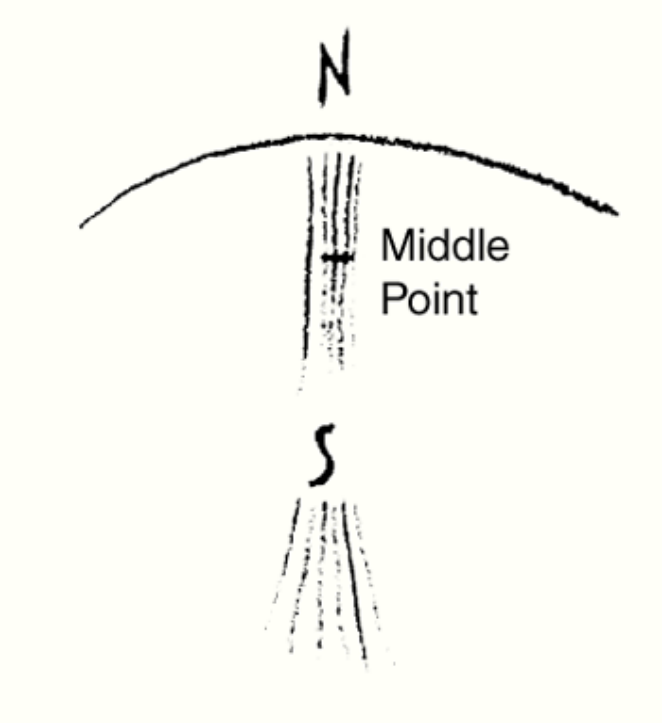

Figure 14

Now, my dear Friends, I have been reading through the written questions; but I believe, if those concerned will reflect a little, they will find the necessary elements of an answer to their questions in what I have set forth. They should but try, in every case, to find the way from what I have been saying to their several questions. We shall advance in this bit by bit. Only one question I should like to deal with briefly. It is as follows: —

"In representing a Science of this kind to the outer world the question may easily arise, to what extent the higher powers of cognition — Imagination, Inspiration and Intuition — are needed for the discovery of these relations between phenomenon. What will be the answer to this question?"

Well, my dear Friends, and if it were the fact that Imagination, Inspiration and Intuition are needed for the discovery of certain things? How then are we to do without Imagination,Inspiration and Intuition, if the fact is that ordinary, "objective", intellectual cognition will not reveal the truth and the reality? What else are you to do than to proceed to higher 'modes of knowledge — Imagination, Inspiration and Intuition? That there is still this possibility — If it is really so that one is quite reluctant to advance to higher modes of knowledge — there is the possibility of simply taking the results of such research and testing them by what is found in the field of external empirical fact. One will always find them verified, of that you may be sure.

Yet in our time these things are not so remote as is commonly supposed. If only the path were really taken, from the ordinary analytical treatment of mathematics to the projective treatment — to a projective form of mathematics and beyond it — if one would cultivate and pay more heed to the idea from which I took my start some days ago, speaking or curves for which one has to go right out of space, one would not find it so very difficult to press forward to Imagination. It is indeed simply a question of inner courage — courage of soul. Today you need this inner courage of the soul for scientific work. Hence it is needful to maintain, for it is true: to the ordinary forms of observation and reflection the full reality will not reveal itself. But if one does not shrink from developing the latent forces of the human soul, depths of reality which would otherwise remain concealed will become ever more unveiled.

This I would like to have said to you in conclusion. For the rest, I would express the wish that all these things, which I can only claim to have imparted by way of stimulus and suggestion and in the barest outline, may stimulate you to research, experimental above all. For this is what we need. We need empirical verification of these truths, which must be taken hold of to begin with in the way we have been doing here. Sooner or later we must get beyond the old foundations of judgment, which have so long been responsible for such conditions as in the instance I shall now relate. I say again, we must get beyond them.

I was speaking to a Professor of Physics about Goethe's Theory of Color. The man has even published an edition of it, with his own commentary. When we had been discussing Goethe's Theory of Color for some time the man declared himself a strict Newtonian. He said, it is in fact impossible for any man to get a clear conception or Goethe's Theory of Color; no physicist can set a clear idea of what it means. You see, his education as a physicist had brought him to this point; he could get no real notion of Goethe's Theory of Color. I for my part could understand it. The modern physicist if he is candid, will have to admit that he cannot. He must first transcend the accepted foundations of present-day physical thinking; he must somehow be able to get away from these old foundations. If he succeeds in this, then he will find the way — for it can be found — from the actual phenomena to that interpretation which is contained in Goethe's Theory of Color and which can also provide an important starting-point for other physical researches, extending even to Astronomy.

Consider without bias the warmth-region of the spectrum and the chemical region of the spectrum, their quite different behavior towards a number of reagents. Even in the spectrum you will detect the contrast I have been describing — the contrast of terrestrial effects and solar. In the spectrum itself we have a picture of the contrast of Earth end Sun, — the same contrast which finds expression in the whole bodily organization of man. Every time you touch another body, perceiving it with your sensation of touch, Sun and Earth are at work. So too, in the spectrum, Sun and Earth are at work. Taking it as the solar spectrum you cannot truly think of it as being put into space just arbitrarily here or there. You must be clear that it is always in the real space — the space that is between Sun and Earth.

Indeed you never have to do with space in the abstract where real phenomena are concerned, for the real things are always there and have to be included. If you do not bear this in mind, you will at last be explaining the origin of the celestial system on the good old pattern — a little drop of oil floating in water, bearing a disk of paper with a pin stuck through it as a pivot, which you begin to turn. The drop of oil gets flattened and little drops detach themselves. A planetary system has arisen: You explain it to your audience: “You see, it is a planetary system”. You compare it with the solar system in the Universe outside — the Copernican conception, — it is the very same! Well and good. Yet you must not forget: There were you the teacher, turning the pin, and therefore — not to be untrue — you should also add the demon giant in the universe outside, turning the cosmic axis, for only so can there arise what you have been alleging. You have no right to use this illustration if you do not include the giant demon. In scientific explanation too, we need to be more scrupulous and careful.

Upon these inner and methodical conditions above all, I have been wanting to lay stress in the present lectures. Next time then we will speak again from other points of view, of certain realms of Science.

****endoffile****