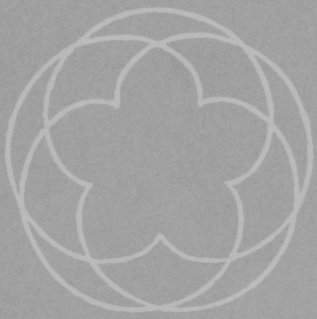
SCIENCE FORUM



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The editors would be pleased to receive such items for consideration (preferably typed in double-spacing). Please address all communications to: Science Forum, c/o Rudolf Steiner House, 35 Park Road, London NW1 6XT

Responsibility for views expressed attaches only to the authors.

Anthroposophy is the name that Rudolf Steiner (1861-1925) gave to his Science of the Spirit. This has given birth to new perspectives and practical activities in the arts and sciences, in medicine, agriculture and education. Information on Anthroposophy and the Anthroposophical Society can be obtained from Rudolf Steiner House.

Back Numbers: *Science Forum No.1* is available from the above address, price £1 plus postage. Additional copies of *Science Forum No.2* are also available from this address. Cheques should be made payable to: 'Science Group of A.S. in G.B.'

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Editorial

What is the most important scientific news of 1980? The launching of a solar observatory? The discovery that Pluto is really two planets? Or, more down to earth, the discovery of a hitherto unknown human sense of magnetism? One could pick out hundreds of such glittering gems of achievement from the casket of man's ingenuity and skill. In this wondrous Aladdin's cave of science, what role do we play?

Clearly, we cannot compete in the same race - that is not our aim. But we can, in a seminal way, work out of an entirely different impulse; we can grope our way along a path almost completely untrodden in modern science, a path which takes cognisance of the spiritual dimension in man and nature. This path by no means turns its back on the many riches which "orthodox" science has to bestow: sound logic, precision, controlled experiments and so forth. Rather, it adds to them. The need to include moral impulses in our equations is becoming increasingly apparent, as for example in the current nuclear debate, the limitation of genetic engineering, the care of our natural resources, the 'microchip revolution', and much more. These are all issues we should be deeply concerned with.

In many areas there is little we can do but apply the tools of spiritual science to understand what is happening in the world. In other areas new research is possible. We hope that, in some small measure, Science Forum will serve both these aspects by making the results more widely known.

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The response to issue No.1 was heartening, but alas it has not proved feasible to publish No. 2 earlier, as was hoped. In order to offset ever rising costs, we have produced this issue using a different format; we hope our readers will find this acceptable. We will continue to work towards the goal of twice-yearly publication.

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Many friends associated with the Anthroposophical Society will remember with gratitude the discussion groups and lectures of Dr. Hans Heitler, who died in December 1979. We are very pleased to publish, in this issue, the first half of a long lecture of Dr. Heitler's, which was given to an ecumenical gathering on Iona, as well as to several anthroposophical audiences. It deals with a problem which occupied Dr. Heitler for many years: the inner nature of nuclear energy.

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Finally, may we stress how important the response of the readership is for the success of this journal. Although it is not always possible to publish everything received, all comments are welcome and are carefully noted. We would be pleased to consider articles, news items, book and journal reviews, letters etc. for publication (see inside front cover for address).

Transubstantiation in an Atomic Age

by Hans Heitler

Adapted from a lecture given on Iona, June, 1965

PART ONE

Originally, I thought it necessary to justify my talks with a lengthy introduction explaining why one of the most mysterious and esoteric events at the beginning of Christianity, the Last Supper, and the latest achievement of science in the field of materiality, i.e. atomic and nuclear sciences, can be placed together under one heading. This task has been superfluous. Dr. Macleod has stated quite clearly in his introduction to this conference that the task of our time is exactly to come to a deeper understanding of these two aspects of the same thing. The Redemption of Matter is the task of both the priest and the scientist. Goethe, more than 150 years ago, spoke of the laboratory bench becoming an altar. He had the feeling, nay, the awareness that when handling any of the substances of the earth, such as a piece of granite or limestone, a quartz crystal or whatever it was, he was in the presence of something which through its form, colour, structure etc., revealed the divinity. Nobody can accuse Goethe of being a mystic. He was a person with the rare gift of the most meticulous and accurate observation. Reading his note books, whether about geology, plants, or the skeleton of an animal, or light and colour, one cannot but admire how not even the smallest detail escaped him, but it was out of this wealth of observation that his deep reverence for all creation arose. Despite the fact that in modern times the powers of observation have been increased enormously with the aid of the microscope, telescope and other more sophisticated instruments, it would be most beneficial if students of science would study the Goethean method.

Yet in the decades following, science went different ways and it became quite fashionable to speak of science versus Goethe. This is still true to a great extent even today, especially with regard to the theory of colour, when Goethe's ideas and those current in optics stemming originally from Newton, are considered incompatible. Only here and there slight indications are noticeable that there is perhaps more to Goethe's ideas than just the fantasies of a man gifted with exceptional powers of imagination.

The Steam Engine

Following the course of events we see how the world in an incredibly short time was completely transformed through the industrial revolution. Not only did pure science penetrate deeper into the secrets of the forces and substances of the earth, but also parallel with it, and not always necessarily as an outcome of new scientific ideas, the world has been inundated with machinery of the most varied kind. The classical example of this is the invention and spread of the steam engine, which at the same time is the origin not only in time but also in spirit, so to speak, of all that followed. In the wake of it countries were transformed from agricultural into industrial ones, incredible riches together with unspeakable misery were created, and in general quite undreamt of prospects opened up and became reality. This process was accelerated with the spreading of electricity and is still continuing to our present day.

For the purpose of this talk, it will be very illuminating to take a closer look at the phenomenon of the advent of the steam engine. First, we have to notice that it did not result out of the body of science available at the time. Practically nothing was known about thermodynamics. Not even the mechanical equivalent of heat was known nor the three laws of thermodynamics, of which now at least two are considered to be indispensible for the design of any heat engine. Whether it is true or not that Watt, the English inventor of the steam engine, was inspired by the dancing lid of a boiling kettle, he did not make use in the first instance of the steam pressure which is obtained when water is boiled in

a closed vessel, but he used the negative pressure, the vacuum which is obtained when steam is condensed to water. So the atmospheric pressure of the outside air pressed the piston down when there was a vacuum in the cylinder. The first machines worked in this manner to pump water from coal mines, notwithstanding the fact that the enormous power of steam pressure was known about. So we have the fact that the steam engine did not come into existence as a straightforward logical extension of what was already known.

In the nineteenth century a German doctor observed on a journey to the tropics that the venous blood of people was much lighter in colour than in the temperate zone. He concluded that the ambient heat helped to keep the blood temperature constant and that less metabolic combustion was needed. He then formulated the first law of thermodynamics in which a certain amount of heat is equated with an equivalent mechanical energy. Then about a decade later, Clausius formulated the second law, which considered heat cycles and stated that it is impossible to transform all heat into mechanical energy. There is always an unavoidable loss. Without going into detail we can say that any such engine, steam, diesel, jet, etc., is considered as a unit in itself in which the heat processes occur in a cyclic form. It is not the first time in human history that heat was used to exceed human or animal power to do the work of those bodily organisations in which the internal metabolic combustion processes have throughout the ages provided the necessary forces.

It is not too far fetched to see in those machine complexes an externalisation of a part of the human bodily organisation. Which part is it? That which in man maintains the constant blood temperature, whether in the arctic or in the tropics, and whether he performs hard physical labour or sits all day long in an office. No animal can quite do this and we are not wrong if we see in this wonderful organisation, which is far from understood by science, a physically observable manifestation of the uniqueness of the human individuality. It is as if at the beginning of the last century the time had come when the human being had matured enough to be able to put out into the world something of his own organisation, albeit in a crude, mechanistic and materialistic form. Out of a deep layer below the consciousness arose the impulse to shed this first seed, or to use another picture, to fashion, even to create out of the substance and forces of the earth - and sun - the first almost unrecognisable image of himself. And this image of man, or more precisely of the warmth organisation of man, serves mankind on an unprecedented scale. At first the railways formed a network over the various countries, and steam or diesel driven ships connected the continents across the oceans; the motor car further helped to take possession of the earth, and finally came the aeroplane. There is not a spot on earth now which could not be reached within two days, and if supersonic flights are coming in it will be only a matter of six hours to go halfway round the world. This perverted, distorted image of man has conquered the earth so far as its surface is concerned. And even space travel depends on engines in which the second law of thermodynamics holds good until such time when nuclear reactions may be used. Then other principles may take over. "I will give you dominion over the earth" has become a reality as far as movement is concerned, in hardly more than a hundred years. What a minute fraction of time this is compared with the aeons of evolution or even with that period of which we have historical records. We may rightly ask, what has happened, what is this impulse which entered into mankind at such a well-defined point of time? Whence did it come? It is of no use trying to explain it by saying that man was not clever enough in previous ages, or that his knowledge of nature had not advanced enough. We find the highest intelligence, which to this day has not been surpassed, already in the Greek and Roman philosophers, and any modern scientist or philosopher would find it difficult to hold his own against the highly sophisticated arguments of the schoolmen. No, there was no lack of intelligence in the last 2500 years, but as I have shown, the steam engine did not arise out of a newly discovered principle of nature. No, it came into existence because suddenly the impulse to have a concentrated source of power, and also to transport people and goods from one end of the earth to the other, simply had to translate itself into actuality. One hundred years earlier it just did not exist, although science in the modern sense advanced by leaps and bounds. We shall have to keep this puzzle in mind and shall return to it later on.

Electricity

The technicalisation of our time did not end with the development of the steam

engine and its allied machinery. A few decades later electricity in all its ramifications threaded its way through the civilised countries and a net was thrown, so to speak, in the form of visible high voltage overhead cables, and still more so in the form of invisible radio waves. These cover quite literally every square foot throughout the twenty-four hours of the day as if a new shell of man-made vibrations had been built; a shell, invisible, completely beyond the perceptive powers of man, penetrating walls and other obstacles and providing the possibility of practically instantaneous communication. What does it matter when a signal is delayed by one - tenth of a second on the way, say, from London to Australia? Given the right instrumentation, messages can be sent and received anywhere all over the earth and even beyond. Signals have been reflected off the moon, and spacecraft in interplanetary space have sent and received signals over many millions of miles. Further and further out reaches this power, and further out extends the man-made world.

Again, we may ask what is it that bursts out with an almost irrestible urge as electricity? There is no time to go into the details even in an abbreviated way as we have done in the case of the steam engine. But we can readily understand that it comes from fundamentally different regions within the human mind and organisation and you will not take it in a trivial and superficial sense when I relate it to that part of the human organism which manifests itself essentially in rhythms as, for example, the blood circulation and the breathing, to mention the two most obvious ones. It is now generally known that the heart is responsible for certain regular electrical impulses which can be registered externally. The brain and the nerves also have electrical emissions although they do not really belong to this rhythmic system. However, these emitted pulses are regular only when there is no conscious activity in the brain or nerves. When the person concerned feels emotions, or thinks, the impulses become very confused and irregular. These few remarks may serve only as indications that it is not altogether amiss to look at electricity as an externalisation of what in man pulses and breathes and thus has in itself a polarisation like inbreathing and outbreathing, intake of blood into the heart and then release, sleeping and waking, etc.

We shall have to consider the latest advance in science and technology again in greater detail as it will be essential in the approach to our main theme. We are very close to the twentieth anniversary of that world-shaking event, when a fire ball of unheard-of dimensions destroyed Hiroshima and two days later Nagasaki, and sinister mushroom clouds rose as pillars of smoke as a sign that man has now at long last opened the gate for the way towards ultimate dominion over the earth, its life or death.

The New Social Order

When we refer to the upheavals 150 years ago as the industrial revolution we do not overstate the case. The old feudal order disappeared to a large extent and was replaced by a completely new social order. At first, it was attempted to transfer the old landlord-tenant relationship also into the new factories and mines, with most unfortunate results. Instead of finding a better lot those who left the country to try their fortune in the towns often found themselves deprived of the natural support which the farmwork had given them, working inhuman hours in appalling surroundings. The former landlord - tenant relationship was replaced by the owner - worker relationship, the worker having been bought; or rather he sold himself if he did not want to starve.

It is not surprising that disappointment, despair, bitterness and revolt resulted, with antagonistic feelings between "them and us" which to our day have not yet disappeared. It was a revolution in the social and economic field but perhaps even more so in the field of learning and science. What a temptation just to look into a microscope and discover new worlds! What wonders could be achieved through chemistry! How the starry heavens expanded and yielded their secrets to the telescope and spectroscope. And wonder upon wonder, when compulsory schooling was introduced so that the workers could read the orders and instructions in the factories, it turned out that in those ignorant low bred multitudes there was slumbering a mind just as alert and capable as in the privileged classes. There was a fantastic spreading of general knowledge, scientific, economic and philosophic, and we see materialism flowing into every field of life. Ideas and social impulses were the result of economic circumstances, and so was progress in general. Economics is based on the material riches of the earth, and what else did science do but bring these riches into the grasp of man. The natural sciences which dealt with natural laws, natural substances and natural

circumstances together with the basic economic idea of profitableness dominated practically the whole of the civilised world. Religion was quite powerless to stem this all-engulfing life and it says a great deal for its inherent power that it did not disappear altogether. It had, however, to be satisfied with a separate existence and the gulf between science and religion widened so much that it seemed to be impossible to bridge it. It is indeed justified to speak of a revolution.

The Revolution in Physics

When natural radioactivity was discovered 70 years ago another revolution started within the scientific edifice which is no less far-reaching, and which has already had repercussions in other fields of life: economic, social, philosophical and, of course, political. How far it will go in the future remains to be seen.

What is this revolution? It is certainly not only because we now possess bombs of an equivalent of many millions of tons of TNT; it is not that we can build power stations in which heat is produced in an entirely new way. The revolutionary character lies in the new ideas which had to be developed. You may feel disappointed that I should put so much weight on the ideas which have grown up in the last few decades in the realm of physics. After all, physics is only a small part in the total of mankind's activities and there are others which have a much more immediate impact. But, ideas come and go, and even science has fashions which change over the years. So is it not exaggerated to put such importance upon what has happened not even in the laboratories but in the studies of people who had the faculty of clothing their ideas in the most abstract and obtuse mathematical formulations? And should this now be the beginning of a new era? It is in the nature of these talks that it would be absolutely wrong if I talked down to you from the high and mighty pinnacle of science as a new revelation. The only task is to make you acquainted with the new thoughts and to try and show that they are much more than mental exercises. This at least is my conviction and if I succeed in stimulating you to this awareness, well and good, and if not I have failed.

As already mentioned, the new era of physics dates from the discovery of radioactivity 70 years ago and the studies which were made by the Curies in Paris. They found that from the mineral pitch-blende a penetrating radiation was emitted in three distinct forms which they called alpha, beta and gamma rays. They isolated an element which they called radium, and they found that this radiation could not be influenced by any means. Whether radium was frozen or heated, melted, evaporated or put into chemical compounds, nothing altered the emission. But what was of much greater significance was that the alpha and beta radiation was of particle (i.e. atomic) nature, yet radium atoms themselves were not emitted. Alpha radiation was found to be helium and beta radiation electrons, and as a result of this emission the chemical element radium transformed itself into another one, this in turn into another, and so on, until the element lead was formed which has no further decay. This was an absolutely startling discovery. In any chemistry book of the last century you will find it stated as an absolute law that chemical elements are the last and simplest form to which any substance can be reduced. Water can be dissociated into hydrogen and oxygen, salt into sodium and chlorine, etc., but nothing can alter these elements. They cannot be divided into anything simpler. Ninety-two elements form the materiality of the earth and everything living on it. Now the law that any of the ninety-two elements are the unalterable ultimate form of matter had been broken. The consequent development showed that in principle any of these elements can be transformed into each other and that it is even possible to create new elements as for example plutonium, which does not exist naturally. We have in actual fact demonstrated transubstantiation and, if you like, the fulfilment of the dreams of the medieval alchemists. The importance of this achievement cannot be overestimated. It brought with it an entirely new way of looking at matter. Whereas previously the very strong feeling existed that the various elements had an identity of their own, and that they were in older times related to cosmic and planetary forces, like gold to the sun, silver to the moon, lead to saturn etc., they have now been reduced to purely numerical relationships of protons, neutrons and electrons, and every element is built up of these fundamental units. Notice how, in this picture, all qualitative values have disappeared in favour of a purely numerical relationship. This is of course only a very simplified description.

Uncertainty

The penetration into atomic structure had

other important consequences. In so-called classical sciences the law of cause and effect was also one of the absolute foundations of the scientific edifice. Under the same conditions the same results will always occur, and as no deviation from this law has ever been observed, the rule of cause and effect acquired the status of an absolute law. This has had to be abolished when single atomic events are studied. The result of an experiment cannot be predicted with certainty. Thus, an electron for example emitted from a well-defined place with a certain energy will arrive in one place. The next electron emitted under the same conditions will not arrive in the same place, the third one at neither of the two, and so on. The various places are not wildly different but group themselves in a certain pattern, and when a great many have been observed a statistical distribution can be expressed which gives the probability of one electron being in a certain place. There is no longer the certainty of strict and predictable behaviour but only a probability. It is as if we tried to focus on a black point on a white wall and see it diffused into a diluting grey over an area. Gradually, the diffusion becomes so faint that it is no longer distinguishable from the original white, and we would say that out there the probability is very small. But now a still more astonishing fact emerges. When a sufficient number of observations are made this 'probability cloud' shows a certain structure. In certain regions there is a greater intensity than in others, quite contrary to the ordinary laws of probability, when one would expect a steady fall off from the centre. The patterns are in fact identical with those which are obtained when light is sent through a pinhole. Then interference fringes appear which demonstrate the wave nature of light. We now started with particles and not with anything of a wave nature and yet we find manifestations which in themselves are contradictory. Prior to particle physics there was one distinct behaviour of a particle stream and the other of light or other non-material forms. A particle stream simply cannot display interference fringes, and, on the other hand, light cannot show a statistical or probability distribution. Yet these contradictory phenomena are observed with electrons or any other atomic particles. The inevitable conclusion was that in the atom we have to do with a material particle and with a non-material something at the same time. One cannot ask which is the real atom, the material or the non-material one. The only answer one can give is that the atom can manifest itself in these two observable forms: mass and radiation. We have to do with a double nature, something which again is against all the principles of classical physics, and so another part of the ground is taken away from under our feet

We are accustomed and in fact rely on the possibility of being able to describe all physical events in space and time. So we can determine with any accuracy we can achieve say, the speed of a motor car at any moment of time, and, simultaneously, exactly where it is. Indeed, life would be most awkward if this was not so. But with a moving atomic particle we cannot do this. We can measure accurately, say, the speed, but then we cannot determine where the particle is, or we measure the place accurately but then we know nothing of its speed. Or we can have both as probabilities, the one for example 30% and the other 70%. If this principle were valid in our ordinary world, this latter would certainly be vastly different from what we are used to. There would be a dream quality about it, or even a nightmare.

Observer and Observed Unite

And finally, we have to mention something which is very difficult to understand, namely the peculiar relation between experiment and observer. When we hold before our mind's eye how radically different the atom really is from the whole of the world which we see and touch and walk on and use for our purposes, how it forces us to dissolve our rigid and precise thinking into something much vaguer, how it reveals itself as a contradictory double nature, then we may also not be surprised if this relationship is also of a peculiar and even startling nature. It turns out that the objective relationship between phenomenon and observer cannot be maintained any longer. Somehow or other, information has to reach us from the moving electron before we can say anything about it. But the energy of this signal has to be comparable to that of the electron, and so whenever we decide to take notice we influence decisively the course of the experiment. It is not even possible to make an experiment in thought only, because, due to its double nature, an atomic particle cannot be described like any other object in three dimensions, but needs six. And the taking notice in thought

has to use these same abstract thought forms as are already in the description of the atom itself. The result is the same as before: a decisive influence has been exerted and even in thought a new situation has been created. Phenomenon and observer are now linked together. Think what this means, especially as all these queer aspects have not remained in the abstract world of scientific theories but have already made their impact in our every-day world in no uncertain terms. The scientist, in his quite justified curiosity, descends from the world of the senses more and more into the very foundations of matter. He discovers there a world alien to what he has been used to; he is forced to express thoughts of a vague and even dreamlike nature in mathematics which have to be, so to speak, as much above that known to be sufficient 70 years ago, as the thoughts in their vagueness are below the precision of classical physics. And there he finds himself inextricably bound up with the objects of his study. The division between subject and object begins to disappear. Nobody knows yet how far this will eventually go. It is quite understandable that the scientist does not like this and it is not often that he deliberately decides to look himself in the face, or whatever it is he meets there. But the fact is appalling reality, that when descending into the atomic underworld, into that world which can only be reached by way of matter, that man meets himself, and now in a much more real manner than in the steam engine. This latter will run and work, and ignores our observation. When dealing with the atom, thoughts of the highest abstraction are influenced in an unprecedented way. What is the secret behind this? Are not thoughts free and so entirely our own that it does not matter an iota whether they are right or wrong? If we make a mistake in our thinking the world does not fall to pieces, and it also does not become a better place to live in simply because we think correctly. Now, down there, in the atomic and, of course, subatomic world, it suddenly does matter. How is it, that the most abstract thoughts, to which one can certainly not ascribe anything of energy or power, can do this? This question is enormously important, because we can now realise that the claim of the scientist that his work is not concerned with good and evil, and that ethics enters in only according to the use to which his research is put, cannot be maintained any longer. It is he who appears in the dreaded mushroom cloud, who lives in the fiery furnace of the reactors, who enters into someone else's body in the form of radioactive isotopes, and so on. Yet even with this, we have not yet solved the great mystery of our time.

Quantum Theory

We have touched upon the riddle of how a real connection can exist between thought and body, and with the latter I don't mean the brain. What is the nature of the thoughts needed to deal with nuclear problems? We have already seen that new and startling forms had to be found, but one more consideration is necessary which, in my belief, can help perhaps in opening a tiny chink in the door before which we stand in such bewilderment. There is one theory, already 60 years old, which has helped perhaps more than any other to further the mastery of the atomic world. This is the quantum theory.

It describes the processes occurring within the atom and in particular in the electronic shells. The electrons are considered moving in certain orbits around the nucleus, but they do not remain in their orbits. They move from one to the other and then back again. Each such "jump" is connected with the emission or absorption of an energy quantum. So if we have, say, a heated wire emitting light, this is due to such "jumps". Energy is therefore also not divisible into infinitely small parts but eventually a smallest item is reached, an energy quantum. Energy in the form of radiation is therefore also seen as small finite quanta. Half a quantum does not exist. The jumps of the electrons alter the total energy of an atom by exactly such a quantum. At the moment there are two continua in our world: length (and therefore space), and time. It is not certain what will happen to them in the future. Energy and matter are not continua. Now these quantum jumps, that is, the movement of an electron from one orbit to another, or in other words a material particle going from one place to another, have to be considered as taking place instantaneously. There is no time involved, and in particular there is no halfway house where it could stop. We have therefore to accustom ourselves to think of timeless transitions in finite space, or perhaps to express it in a somewhat different way, we are aware of one position at a given time and then of another. What happens in between escapes our observation, except, that in

that non-observable interval an energy quantum is emitted which moves away with the velocity of light. Thus within the atom we have such a transition which escapes our observation, and this is not because our power of observation is not good enough. The reasons are quite fundamental within the framework of atomic physics.

Thinking and Will

It is extremely difficult to imagine such a process. We have all experienced sitting in a fireside chair and falling asleep without really noticing it. And only when we wake up again are we aware that the clock has moved on. However, there is no reason why we should not have stayed awake and experienced the passage of time in the usual manner. Is there also within the human being as a totality a place where a process occurs which we cannot follow through, where there is a gap in our consciousness which cannot be filled? There is indeed, but because it is unobservable it is rarely mentioned. In order to find it we have to consider the relation between consciousness and action, or thinking and will. The human being can be described as moving between these two poles. There are innumerable actions, expressions of our will, which we perform in our daily life and of which we are quite oblivious.

We walk along the street and we do not direct each step, still less the contraction and relaxation of the innumerable muscles involved. If we had to, we could not get anywhere. The action of the heart is completely beyond our control. We would not live long if it depended on our conscious awareness and direction. On the other hand we also do quite a lot of thinking but here we are less interested in the doing than in the result. If I asked you to give a proof of the famous theorem of Pythagoras, it may be quite an effort for some of you, but again, this effort is only a means for the end and you would say: This is it; you would hold before your mind's eye the solution and inherent in that "this is it" would also be the certainty that it has been so yesterday, or in Moses's time, and that it will be so to the end of time. Such is the characteristic of thinking that its results in the form of concepts are brought, so to speak, out of the totality of truth which existed from time immemorial, whether expressed by human speech or mind or not. And the only difference it makes if such a thought is thought for the first time is that it has been brought from a realm beyond human awareness into the latter.

In action we really have the exact opposite. Nothing of it existed before. We may have the intention to do something, but the intention as such does not alter anything. As soon as we take the first step the world has been altered. We have raised a little dust, we create a movement of the air, the sound of our step spreads out into space, and so on. All these disturbances are new and have their repercussions in the future. In our thinking we live in what comes from a kind of immovable world of ideas, in our will we create something which has consequences in the future. Thinking and will are the polarities of past and future in which man stands.

How, then, can we perform an action whose impulse comes clearly from our thinking? We decide to go for a walk. Undoubtedly we would never set a foot outside if it wasn't for conscious idea that is within our thinking. How does this idea go over into the movements of our legs and all the rest of it? Quite clearly again our intention, though indispensible, does not carry us anywhere. Absolutely nothing would happen if we had only the intention, and it is not an idle saying that the path to Hell is paved with good intentions. They fill us with a feeling of anticipation of the completed act. "I would like to go to the wood" means in reality that the wood presents itself to me as a desirable place and I anticipate the shade, scent, colour etc. Now I may be too lazy to get up and walk. But if my desire to be there overcomes my laziness, then at a given moment things begin to happen. When we want to investigate what is there in addition to the intention we come up against extraordinary difficulties. We can just about feel that something goes down into our organisation and then to our surprise we move. A really accurate observation can say the following: In our conscious intention there arises something of which we can get only the shortest of glimpses before it disappears into the darkness of our organisation. And then back comes the awareness of the action. Something escapes utterly from our observation, namely, how the action comes about. The physiological or psychological idea that we send a command along the nerves to the muscles is theory without helping us a bit. No matter into how minute a detail we divide the simplest of actions, we always meet this gap over which we have to jump but into which we cannot enter with our consciousness. We

are justified in calling what enters and fills the gap in that dark moment, and which is really the element without which we cannot move, the Will. I am quite aware that this may be a rather unusual usage of the word. But when we see on the other hand that it extends in a diluted form into the conscious pole as intention, and that this is paralysed through its strong connection with consciousness, the pure element in an action - though it escapes observation - is a very real component. It is that element which makes us move and perform deeds preconceived in our ideas.

It must be an extraordinary quality that can establish the connection between our consciousness and our action. But it does not allow us to be present at the actual mystery of the deed. On closer consideration it is just as well that these regions are barred to us, at least for the time being, because the Will and the appropriate metabolic processes are one. Every muscle is a metabolic organ, either for combustion or building up. Interference in these processes with the power of thinking, as it is at this time of our evolution, could only be disastrous. Something which is essentially alive cannot be ruled by something which is essentially static.

Man Externalised

In our study of the nuclear sciences we have found processes whose equivalent in man we find to be the region where will, metabolism and action take place; we cannot penetrate into this region but can at best approach it by jumping to and fro. Through this we may gradually strengthen our feeling and dim awareness of an impenetrable dark abyss. Such actions, though clothed in mathematical formulae, we perform in our thinking when we work with the quantum theory. What then is it in man, that is externalised in such an extraordinary manner?

To answer this question let us look once more at actions which have their origin in the conscious pole. We may have first an idea, then an intention, then we perform an action, and this latter, big or small, alters the context of the world. And then we may stand back, consider what we have done, and judge it as good or otherwise. Of course, we also prejudge by putting the idea of the completed deed before our mind. The judgement of good or evil is always done after either the actual or the imagined deed. A deed carries, therefore, apart from its deep secret, another element which we receive and recognise as moral or ethical. Morality is always bound up with deeds whether performed or imagined, and it is the stronger the more we narrow down the gap by observation from both sides. We have thus to consider the following complex: Idea - intention - impulse plunging into darkness. Arising out of it on the other side: awareness of action. Entering into the darkness from above, Will; from below, metabolism. And spreading like an aura from the centre, judgement of good and evil, conscience. It would be difficult to find an element in man in which more of his totality is involved, and most certainly, this description is by no means complete.

We find in the thought methods of quantum theory practically the same mechanism as we have found in man, and we may begin to appreciate the significance of our atomic sciences. All efforts have been made to present the ideas in the light of clear thinking of a mathematical-scientific kind. But we cannot exercise our thinking in this way without being involved in the other regions as well. Inevitably they are called up, whether noticed or not. And so it is beginning to evolve as a fact more and more that we are faced, in atomic processes, with the complex of man we have just described. Again man's inner being has been externalised. What takes place within our bodily organisation under the guidance of those powers who have built it in their image and who have hidden it from the death-dealing powers of knowing, now stands before us openly for all to see. Yes, there is man, in his totality. He yielded to the necessity to give up his precise thinking and immersed himself into the accurate - vagueness of the uncertainty principle, of the double nature of the atom, of the complementarity principle; but look what he has gained! Dominion over the earth. He can annihilate and create substances at will, he can deal total destruction to everything living, he can grasp the bowels of substances and force them to yield their inner powers. And within all this there are contained those forces which in man are called Will, metabolism and conscience. You will find nothing of this in the textbooks nor in popular science books. You may detect here and there a vague hint of it, but on the whole nothing of this is present on the level of common consciousness; that is the result when the moral forces are deliberately suppressed or belittled. Conscience goes underground but cannot be extinguished. It will come up in other forms, sometimes in the urge to violence, but in general in

the form of fear, and when this becomes strong, in schizophrenia.

The final part of this lecture will be printed in the next issue of Science Forum.

Obituary

HANS HEITLER was born in Karlsruhe, Germany, in 1899. His father was a professor of engineering, and from early childhood Hans was determined to become an engineer too. Although his training was interrupted by the 1914 - 18 war, he succeeded in following this career until the late thirties. He then left Germany because of the Hitler regime, and came to England. Here, in his middle life, he took up a completely new career as a physicist. In 1947 he received a PhD degree from Bristol University, and then became involved, as an experimental physicist, in the exciting new research into cosmic rays then being done in Bristol, under the brilliant leadership of Nobel Prize winner Cecil Powell. This was pioneer work at the time and involved the use of high flying balloons.

Upon his retirement from the University in 1965, he joined the staff of St. Christopher's School for children in need of special care, based on the curative educational principles of Rudolf Steiner. He was first in charge of the student's training course, and later took science lessons with the older children. These were enjoyable years for Hans; not perhaps so exciting as his time at Bristol University, but richly rewarding and giving fulfilment in old age to his years of anthroposophical study. He joined the Anthroposophical Society in 1927, and although never very active while living in Germany, after he came to England he gave many lectures and wrote many articles based on anthroposophy.

He was always conscious of the discipline a training in scientific methods gave to his spiritual strivings. It was this consciousness that gave him a special insight, not just into nuclear physics as such, but into an awareness of the path the scientist had taken to bring him into the realm of nuclear energy. He felt strongly that this aspect was only too often overlooked.

Towards the end of his life he suffered ill-health, and was forced to withdraw from his many activities. He died peacefully on 20th December, 1979.

Margaret Heitler

Nicola Tesla

Electrical genius

by Steven Roboz

One morning, some years ago, lower Manhattan began to shake. It was like an earthquake. Water pipes burst, plaster fell from ceilings, windows cracked. The vibration grew stronger. People rushed into the streets from the neighbouring tenements.

Police headquarters in Mulberry Street had little doubt as to where it was all coming from. A squad rushed to the loft building on Houston Street where Nikola Tesla had his laboratory. They had had experience with Tesla before.

They didn't wait for the lift but took the stairs. As they burst into the laboratory the building was swaying as if the walls might crash at any moment. They saw a tall man pick up a sledge hammer and smash a small machine attached to a column in the middle of the room. At once the noise and vibration ceased.

Tesla was always secretive about his inventions and he refused to reveal anything about the now hopelessly shattered machine which had caused the miniature earthquake. There have been many attempts by other scientists to explain the violent effects it produced that morning, but none of the explanations were very convincing.

Tesla later described what he called his "telegeodynamic oscillator", presumably a similar machine. "It is so powerful," he said, "that I could now go over to the Empire State Building and reduce it to a tangled mass of wreckage in a very short time. I could accomplish this result with utmost certainty and without any difficulty whatever. I would use a small mechanical vibrating device, an engine so small you could slip it in your pocket. I could attach it to any part of the building, start it in operation, allowing 12 or 13 minutes to come to full resonance. The building would first respond with gentle tremors and the vibrations would then become so powerful that the structure would go into resonant oscillations of such great power and amplitude that rivets in the steel beams would be loosened and sheared off. The outer stone coating would be thrown off and the skeleton steel structure would collapse in all its parts."

In the face of claims of this sort and Tesla's refusal to give details and specifications of his discoveries, the natural impulse of the average man is to label him a charlatan. Before going further it will be well to emphasise that in spite of his eccentricities and all the evidence to the contrary, there is no question that he was one of the greatest scientists. Whatever the layman may think of him, other scientists have no doubt of his quality. His achievements were recognised during his lifetime by all the world's scientific societies. He was awarded the Nobel prize and refused it.

As he grew older he became even more secretive and suspicious. He never put anything of importance on paper. His lifelong reticence and distrust of the men with whom and for whom he worked were due, probably, to certain disillusioning experiences he had had as a young man. There is considerable evidence that he was victimised more than once by the men over him.

Tesla was born in 1857 in what is now Yugoslavia. As a young man he worked in the telegraphic engineering department of the Austrian government and later as engineer for an electrical company in Budapest. From there he went to the Continental Edison Company in Paris. He was sent to Strasburg to re-start a power house after a serious accident. He was successful, but when the time came for him to collect a promised bonus he could find no one in the company who had authority to carry out the agreement. One of his friends in the company, who was also a friend of Thomas A. Edison, suggested that America would be a much better place for a brilliant young man to have a successful career. He gave Tesla a letter of introduction to Edison.

Tesla sold his books and few possessions to raise money for his passage to America.

He arrived in New York with no money, his wallet and luggage having vanished on the journey. But with the letter to Edison still in his possession, he soon had a job at the Edison laboratory in West Orange.

Troubles with Edison soon began - troubles which reverberated down the years in the electrical industry. Edison was a shrewd businessman. Tesla was a foreigner, not too familiar with the English language, touchy by nature or by experience and never an easy man to work with. He was a valuable man in the design and operating sections of the Edison plant and was repeatedly promoted, but with no substantial increase in salary. He found many ways in which the dynamos Edison was making could be improved in design to increase output and lower operating costs. He outlined his plans to Edison who told him to go ahead, adding, "There's $50,000 for you if you do it!"

Tesla's designs, replacing the long core field magnets then in use by the more efficient short cores, proved successful and he asked to be paid the $50,000. Edison replied, "Tesla, you don't understand our American humour".

Tesla was shocked, and resigned his job immediately. For a year he worked as a day labourer, digging ditches. Finally the foreman of the gang became impressed by what Tesla told him of his inventions. Through this man, an officer of the Western Union Telegraph Company became interested. A corporation known as the Tesla Electric Company was formed. Its laboratory was on the street which is now West Broadway. Here, in these modest quarters, started the war which split the electrical industry for years, and in which Tesla was ultimately the victor.

It was a tremendous war between the advocates of direct and alternating currents. Edison was on the direct current side and had power houses operating in several cities. Alternating current was no more than a scientific curiosity until Tesla's inventions made its use possible. He had discovered the fundamental principles on which his system was based - that of the revolving magnetic field - before he left Europe. Now he produced three systems of alternating current machinery, dynamos, motors, transformers, distribution systems, for which he was granted seven patents in 1887, and 23 more later.

Direct current could be supplied only within a mile of a power house. Alternating current, however, could be transmitted hundreds of miles. The electrical industry quickly realised that a revolution was in the making. Tesla was invited to deliver a lecture before the American Institute of Electrical Engineers. This time he put reticence aside and described in detail the electrical system which today is in operation all over the world.

George Westinghouse, head of the Westinghouse Electric Company, became interested. He offered Tesla a million dollars cash for his alternating current patents, plus royalties. Tesla accepted. This transaction, and the million dollars, undoubtedly restored - temporarily - his faith in human nature. Later, when the company was in a period of financial depression, he agreed to relinquish the royalties.

In 1891, Tesla was sitting on top of the world. He was young, rich, distinguished. At the Waldorf and Delmonico's certain tables were always reserved for him. He gave fabulous dinner parties. After dinner he would conduct his guests to his laboratory where he put on exhibitions that were much more astonishing than those of professional magicians. Doubtless some of the wierder machines he exhibited had no other use than to startle his visitors. However, there was no deception when he allowed hundreds of thousands of volts of electricity to pass through his body to light a lamp or melt a wire which he held in his hand. His fame went round the world. European scientific societies invited him to lecture before them. The Westinghouse Company, using Tesla's system, supplied all the electricity for lighting and power at the Chicago World's Fair of 1892. Tesla had an enormously popular exhibition of his own at the fair.

The harnessing of Niagara Falls by the installation of his polyphase generating system added to his reputation. In 1894 - 95 he built what was probably the first radio transmitting and receiving station. Messages were sent from his laboratory on Houston Street in New York to a Hudson River boat 25 miles north of the city. One of his most sensational projects was to light up the whole sky at night so it would be as bright as day. His plan was to conduct high frequency currents to a height of 35,000 feet where they would cause the entire atmosphere to become luminous. However, the attempt was unsuccessful.

Things were now going badly with him. After he received his million dollars from Westinghouse he began to live like a prince - and he continued to do so all the rest of his life, whether or not he had any money.

He received immense sums from friends for his research, but he was not interested in commercialising his inventions. He intended to do so, sometime in the future; but always he was so intent upon new discoveries that he couldn't bother to make money. He fully expected to live 150 years, so there was no hurry. Sometimes he was evicted from hotels because he couldn't pay his bills. Usually, some friend would then give him twenty-five or fifty thousand dollars and a new era of wonderful laboratories and extravagant living would ensue.

At the first Electrical Exhibition in 1898, Tesla built a large tank in the middle of the arena and in this he placed an iron hulled boat fitted with a radio receiving set and numerous motors. He was able to control the movements of the boat by radio impulses sent from the far end of the arena. He went on to develop a robot man for which he was granted a patent in 1898. He tried, without success, to interest the War Department in his wireless-controlled machines. One of these machines was described in the "Century Magazine" of June 1900. He wrote: "In an imperfect manner it is practicable with the existing wireless plants to launch an aeroplane, have it follow an approximate course and perform some operation at a distance of several hundred miles. A machine of this kind can be controlled mechanically in several ways and I have no doubt that it may prove of some usefulness in war...By installing proper plants it will be practicable to project a missile of this kind into the air and drop it almost on the very spot designated, which may be thousands of miles away."

This was written many years ago, remember.

Tesla had costructed larger and larger oscillators in his New York laboratory, until with one producing 4,000,000 volts he arrived at the limit of safety for a city building. He needed a structure in the wide open spaces where he could build even larger coils. As usual he was broke, but money was offered by friends and he embarked on the Colorado Springs project. He constructed a fantastic building to house his giant oscillator. Its most striking feature was an 80 foot tower from which projected a mast 200 feet high, surmounted by a copper ball three feet in diameter.

In his biography of Tesla, 'Prodigal Genius', John O'Neill recounts what Tesla told him he was trying to do at Colorado Springs: "With the earth set in electrical oscillation, a source of energy is provided at all spots on the earth. This could be drawn off and made available for use by suitable simple apparatus which would contain the same elements as the tuning unit in a radio set, but larger, a ground connection and a metal rod as high as a cottage. Such a combination would absorb at any point on the earth's surface, energy from the waves rushing back and forth between the electrical north and south poles created by the Tesla oscillators. No other equipment would be needed to supply light to the home provided with Tesla's simple vacuum-tube lamps, or to produce heating effects."

He succeeded in transmitting power considerable distances without wires. On one occasion, he lighted a bank of 300 electric bulbs 25 miles from the laboratory. In 1899 he returned to New York to build a broadcasting station at Wardencliff, Long Island, but the project was never completed for lack of money.

When pressed by friends to commercialise some of his discoveries, he replied: "That is small-time stuff...wait until you see the magnificent inventions I am going to produce and then we will all make millions."

He next turned to the development of a steam turbine engine. He built an experimental engine, followed by a larger machine that was installed at the Waterside Station power house of the New York Edison Company, but there were unexplained complications. The project was dropped. Tesla believed this was due to the influence of Edison. The old feud persisted.

The Nobel Prize for physics was awarded in 1912, jointly to Tesla and Edison. It would have meant $20,000 for each of them and as usual Tesla was broke. But he refused the prize. He considered the placing of Edison, "a mere inventor", in the same category as Tesla, a discoverer of new principles, an insult. In 1917, he was awarded the highest American engineering honour, the Edison Medal, and refused it. This time, however, he was persuaded by friends to accept the honour. He was presented the medal by an eminent engineer, who said, "Were we to seize and eliminate from our industrial world the results of Mr. Tesla's work, the wheels of industry would cease to turn, our electric cars and trains would stop, our towns would be dark, our mills would be dead and idle...His name marks an epoch in the advance of electrical science."

Friends have told of his curious eccentricities. He bought a new pair of gloves each week and threw away the old ones. He demanded a fresh towel every time he washed his hands. He never shook hands with anyone;

if his hands were seized, he would be upset for hours.

No woman ever influenced his life. But he loved pigeons. When he stopped before the public library in New York and gave a low whistle, flocks of pigeons would fly down from all directions, covering the sidewalk and even perching on him.

Towards the end of 1942 it became evident that Tesla was not going to achieve anything like the 150 years of life he had anticipated. He stayed in his hotel room and refused to see even old friends. On Tuesday morning, January 5th, 1943, he was found dead in his room. Death was declared due to natural causes. Agents of the FBI appeared and impounded all the material in his safe because of reported inventions that would be of use in the war.

It is interesting to speculate about the secrets Tesla carried with him to the grave. In his later years he would not reveal any details of his discoveries and projects. His reply to inquiries was invariably the same: secrecy was necessary until he could obtain patents; he couldn't apply for patents until he had made working models, he couldn't make models because he had no money.

Reference: 'Prodigal Genius' by John O'Neill, Tartanbook. American Mercury, M. Colladay, Jan. 1959.

News & Comment

THE SCIENTIFIC AND MEDICAL NETWORK

The Scientific and Medical Network was formed initially by Dr. Patrick Shackelton and George Blaker, who conceived the idea quite independently, then met and proceeded to found the Network in 1972. It aims to attract medical and scientific people of high academic standing who are prepared to state that they believe in a spiritual basis for the natural universe, that they wish to extend the boundaries of orthodox science (including medicine) to embrace phenomena which are, in their view, factual, but which are not recognised as lying within the framework of present scientific laws. This includes paranormal phenomena, alternative medicine, intermediate technology, etc., and also implies a belief in a non-mechanistic, anti-reductionist view of the universe, and of man, within which science must be contained. For practical reasons, the membership is kept confidential.

In 1977 the S.M.N. held its first open meeting, at 'The May Lectures', which it had inherited a few years before (and at which Charles and John Davy had already lectured). Ironically, this first meeting was held at the Royal Society of Medicine, home of orthodoxy! It was at this meeting that Dr. E.F. Schumacher gave one of his last lectures before his tragic death in September of that year.

Annual conferences, open to the public, are organised, at which reputable and often famous speakers give their views and critical assessments on subjects not usually accepted as orthodox. Cassettes of May Lectures since 1977 are available (1).

A number of research projects are currently being organised, including (a) biorhythms and (b) basic scientific research into homoeopathy. Under (b), it is aimed to investigate the nature of potencies (not clinical trials, etc.) to be carried out in a University laboratory under the direction of a recognised independent professor, so that the results may be published in an independent scientific journal of international repute. (Much help has been received here from Weleda Co. - from Hella Levi and Martin Viner - as well as from other sources.)

The network also organises an annual symposium, in September, for students, who should be in sympathy with the aims of the Network, and must be sponsored by a member. This is now in its fifth year, and is one

of the outstanding successes of the organisation. Students keep in touch with each other, adding to their number each year, and are now a really active living force among their colleagues. For the last two years, the Student Network has held its week's symposium at Emerson College, Forest Row, where it is to be held again this year, by request, because the students were so appreciative of the surroundings and the facilities which were offered them (thanks to John Davy).

Membership is by invitation; details are available from the Secretary (2).

Jean Kollerstrom

Notes:
(1) A list of cassettes is available, on request, from Jean Kollerstrom, 9, Primrose Gdns., London NW3.
(2) Details of the Network, and of the May Lectures, may be obtained from George Blaker, Lake House, Ockley, near Dorking, Surrey.

THE MAY LECTURES, 1980

This event was held at the opulent National Liberal Club, London, on April 12th - 13th. The opening lecture ("The Psyche in Medicine") was by Dr. Arthur Guirdham, author of "The Cathars and Reincarnation" among other books. Departing from his usual style of in-depth case-studies, he presented his audience with many fragments designed to illustrate his central thesis: that human illness in incomprehensible if the psyche or spirit is left out of account. Dr. Guirdham's many years of deep involvement in psychiatry have led him to such concepts as reincarnation and possession by discarnate entities - conclusions apparently not shared by all members of the audience.

Professor John Hasted ("Paranormal Physical Phenomena") described experiments to measure "physical phenomena", as, for example, the metal bending of Uri Geller and others. By using very sensitive strain-gauges attached to a sample of metal, a response may be measured electronically when certain individuals "mentally bend" the metal, even though actual bending may not always be visible. As to the problem of whether the subject might not be affecting the measuring and recording apparatus directly, Professor Hasted acknowledged that this would be a possibility: much more work remains to be done.

Professor Arthur Ellison ("The Way Ahead - What Choice is Before us?") gave a résumé of different meditational paths. He seemed to concentrate on John Lilley's investigations in which sensory stimuli are suppressed, and concluded that more or less anything we could conceive could become a reality.

Dr. Brian Goodwin spoke on "Structuralist Biology: a Vision of Creative Harmony in the Living Realm". The structure and form of organisms reveals a harmony which is difficult to explain in reductionist terms; a field approach is more appropriate. For example, the morphology of cell division in the early stages of embryonic growth displays field properties, which correspond mathematically with harmonic functions.

Professor William Byers Brown spoke on "Wolfgang Pauli - Physicist and Dreamer". He described the unlikely relationship between Jung and Pauli, in which the former analysed the dreams of the latter over a nember of years. The dreams revealed an unconscious preoccupation with symmetry - the same principle which dominated Pauli's work on the arrangement of electrons in atoms.

These lectures, with the exception of Dr. Guirdham's, are available as cassettes (see previous item for address). Why this omission? If a speaker knows he is being recorded, he measures his pace accordingly, but in so doing he is in danger of losing the spontaneity which often makes a good lecture (indeed, one speaker merely read directly from a script). Dr. Guirdham, however, made no such concessions to the tape recorder, so unfortunately his lively contribution to the conference goes unrecorded.

Howard Smith

SYSTEM X .

The British Post Office is pressing ahead with plans to replace the existing national telecommunications network by 'System X'. The first exchanges are already in service, but it will take about 20 years to complete the change-over. System X is claimed to be the most ambitious application of electronic

digital techniques in the world. Digital systems are based on the principle that 'everything can be expressed by numbers', whether it be speech, music, data, switching instructions or line transmission multiplexing. The practical realization of these systems has been dependent on the creation of electronic devices operating at speeds almost beyond human comprehension.

Rudolf Steiner often pointed out that, in the modern world, we have to work with Ahriman, but it is important that we should not be just carried along by technological developments. The telephone system is an integral part of modern life: in common with other aspects of life, its mode of working will, during the next decade, become increasingly Ahrimanic. If we are fully aware of what is happening, it will be easier to ensure that human values and needs take precedence over technological and economic considerations.

Hedley Gange

SCIENCE GROUP NEWS

■ The Science Group of the AS in GB has now been in existence for over 18 months. What have we achieved? Our main activities are still the Conferences and the Science Forum, but we are always looking for new avenues of expression.

■ The Editors would like a Member to take over distribution of this journal. This involves storing the journals and processing orders as they arrive. We also need someone who feels committed to the aims of the Science Group, to act as "Sales Manager", bringing the journal to the attention of those organisations and groups likely to be interested.

■ We hope to develop our "Books & Journals" section to provide a good abstracting service, offering a brief survey of relevant literature (anthroposophical and other). For this to succeed we depend heavily on readers sending in reviews and abstracts of sources which they happen to know of. Even a reference, title and a sentence or two, published as an abstract, may be just the thing that another reader is looking for in his research. We appeal for your help in this section.

■ Much important work is published in foreign languages, particularly German. We are looking for translators. Any offers?

■ If any Member wishes to purchase the "Warmth Course", they may do so through the Group, as we have been offered concessionary rates ($10 instead of $12.5, plus postage). If you are interested, please write straight away to Howard Smith (17 Armoury Rd, West Bergholt, Colchester, Essex, CO6 3JN).

On the Importance of Using the Right Zodiac

by Nick Kollerstrom

"Accordingly the God set water and air between fire and earth, and made them, so far as was possible, proportional to one another, so that as fire is to air, so is air to water, and as air is to water, so is water to earth, and thus he bound together the frame of a world visible and tangible."
(Plato, Timaeus)

As would appear from the above quotation, if one is going to assume that the four elements are relevant to the construction of things - as biodynamic farmers do in the way the moon's passage around the zodiac affects the growth of plants - then one must surely assume to start with that some principle of symmetry or balance regulates their operation.

However, one is not compelled to make such an assumption: it may not be regarded as self-evident, and in fact the calendar utilised by biodynamic farmers uses a zodiac in which the four elements are distributed in an irregular, unbalanced and asymmetric manner; and the grounds for so doing are that what are regarded as the visible constellations in the sky are taken as demarcating the areas of cosmic space with which the four elements are associated.

Taking these constellation divisions as used in the biodynamic sowing calendar, which are the same as those used nowadays by astronomers to define the boundaries between the twelve constellations on the ecliptic, which are essentially similar to the constellation divisions marked out by Ptolemy in the second century A.D., the area of cosmic space occupied by the three earth-constellations (measured as degree angles round the ecliptic from the earth) adds up to just over half (56%) as much again as the total area occupied by the three air signs. The earth constellations of the zodiac are thus longer than the air constellations (e.g. Libra [air] 18°; Virgo [earth] 46°, etc. - see Fig. 1).

This means that on average the moon in the course of its 27½ day journey round the zodiac will spend some one and a half times as long in the earth constellations as it does in the air constellations.

I take the view that for aesthetic reasons of symmetry this cannot be so, that if one is going to postulate four different primary forces working into the plant realm then their operation must be symmetrical. One cannot claim that the operation of cosmic powers are of irregular and unbalanced timing just because imagined star-pictures in the sky are of unequal size. A historical perspective is necessary for sorting out this difference between constellations (unequal size) and zodiac signs (equal 30° intervals).

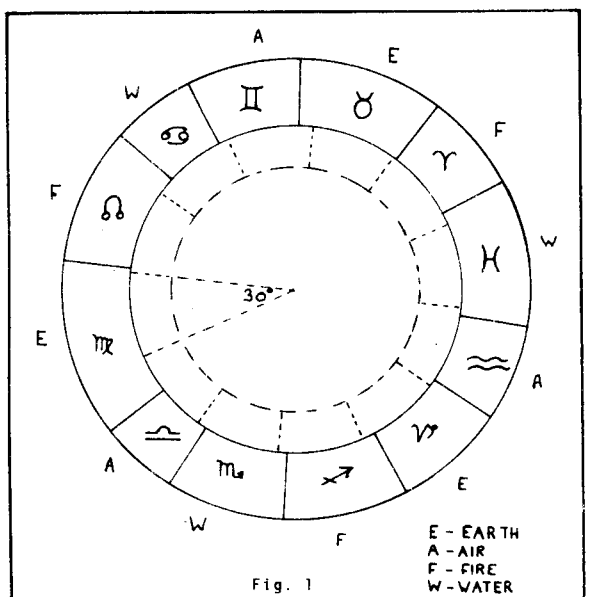

Fig. 1

Modern Constellation divisions in relation to the Sidereal Zodiac (30° divisions), and showing the relation of the Zodiacal signs to the Four Elements.

The earliest zodiac was of twelve equal interval signs which 'perceived', if one may use the word, the constellations to be of equal length: Virgo, for example, was 30° and this is the zodiac which I have argued elsewhere biodynamic farmers ought to be using (1). Now this star-based

zodiac came to be forgotten by the West in favour of the sun-based tropical zodiac, defined by the sun's position in space at the equinoxes, which subject does not here concern us except to say firstly that its divisions are now rather different from those of the original sidereal star-zodiac, and, secondly, that when biodynamic farmers started to realise that the moon's journey around the constellations was important for crops, the ancient 2500 year old sidereal zodiac was almost unknown in the West.

So they adopted the constellations. Here the distinction should be noted in Ptolemy's work between the twelve equal divisions, which were taken as marking out the cosmic powers in the heavens, and constellation boundaries which related solely to the physical location of the stars; biodynamic farmers should realise that the latter have never, never been used by any previous cosmologers or astrologers for demarcating the operation of cosmic powers, they have only been used for astronomical purposes.

Although always used in the East, the rediscovery of the sidereal zodiac in the West has been very recent and it is only in recent decades that it has come to be generally known at least among astrologers. Thus if biodynamic farmers changed over to using the sidereal zodiac they would be using one widely known and taken very seriously, instead of using one at present which makes them a mere oddity.

After looking at this problem from a logical and then from a historical perspective, we arrive thirdly at the 'visible and tangible' question of which system accords better with experiment. Are farmers in fact better off using the sidereal rather than the constellational system? If so, what is the evidence?

Published experimental work by Thun (2), Abele (3) and Graf (4) shows how variations in crop yield depend on the moon's position against the constellations at sowing time. For those not familiar with these experiments, the general idea is that final crop yields will be larger for the rows sown when the moon was in one of the three signs of the element supposed to be associated with the crop being grown, e.g. potatoes in earth element, lettuce in water element,etc. However, all such experiments were conducted by sowing one row only each time the moon was near the middle of a constellation, over a period of one month, twelve sowings in all, and thus they in no way discriminate between the two systems here in question, since the middle area of each constellation always falls over the corresponding sign, it being usually only near the boundaries that the two systems differ.

The two systems differ 15% of the time: over 15% of the ecliptic circle the constellations as defined and the sidereal zodiac say different things. Since the amplitude of the effect obtained appears to be remarkably large, the experiments referred to having found yield increases of 30 - 60%, one would expect it to be a straightforward matter to ascertain which system of divisions better fits the data.

Sowing experiments by Colin Bishop in Wales were performed over 1976 - 78. It may amuse the reader that Mr. Bishop, as one quite unfamiliar with the biodynamic calendar and interested in astrology, was expecting that the effect would follow the tropical zodiac, and was quite surprised when a distinctly sidereal rhythm appeared in his results. It was as an attempt to resolve this issue that he sowed so many rows in 1978, two in the morning and two in the afternoon, over some forty days. His results confirmed that lettuce grows best in sidereal water moon-signs, and radish best in sidereal earth moon-signs, and also confirmed the large amplitude of the effect, as mentioned.

In 1976 he sowed one row of lettuce near the middle of each moon-sign/constellation, and the results of this are not relevant to the present issue for the reason referred to in connection with previous experiments.

In 1977 he sowed rows of lettuce whenever convenient over a two-month period, and the mean yield per row*, harvesting each row after a three month growing period, is shown in the graph (Fig. 2). Also shown on the graph are the times when the moon is in both the water signs (sidereal)** and the water constellations. The Table shows these yields added up according to sidereal

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* That is, the total weight of lettuces in the row divided by the number of lettuces.

** Note that the equal-interval zodiac translates into unequal intervals of time, between two to two and a half days per sign, owing to the moon's varying angular velocity throughout the apogee-perigee cycle. The times for the moon's entry into and exit from sidereal signs were obtained from Omega Associates Sidereal Ephemeris (American Association of Astrologers, U.S.A.), at sowing date.

moon-sign elements (Table 1). Theory predicts maximum yields in water moon-signs and minimum yields in earth moon-signs, and this was found: as can be seen, the mean of the former is more than double the mean of the latter.

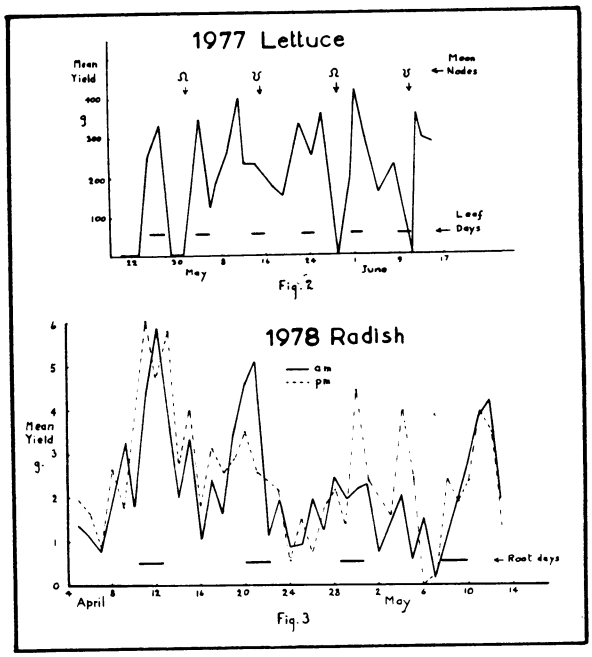

Fig. 2

Fig. 3

Surprisingly, if yields are grouped according to constellation divisions this water maximum does not appear (see Table 2), although a minimum can still be seen in the earth moon-constellation sowings.

The 1978 radish sowing experiment is shown in Fig. 3, each point being the mean of two rows sown. These results again show a fine pattern of celestial influences, a fine star-rhythm running through the data: a 9.1 day cycle defined by the moon's position in space, with maxima in the three earth signs as theory predicts and minima in the three water signs. As shown, if the mean of all 21 earth- and moon-sign sowings is taken and compared with the mean yield of all 18 water moon-sign sowings, the former is 90% greater than the latter (see Table 3).

Now, since the earth constellations mostly overlap the earth signs naturally this increase also appears if grouping is done by constellation instead of signs. So let us look at the sowings which fell in the earth constellations but outside the earth signs. There happen to be six of these, out of a total of 78. Their mean yield is 2.63, which is nearer to the means

TABLE 1

1977 lettuce yields per row (g) grouped according to sidereal moon-sign element at sowing time. (means shown in bottom row)

Earth	Air	Water	Fire
0	255	340	0
0		352	125, 187
269	413, 235	235	184
159	340	255	368
0	198	425	277
150	238		0, 368, 298
292			
145 ± 125	281 ± 85	320 ± 77	201 ± 127

TABLE 2

1977 mean lettuce yields per row (g) grouped according to constellation moon-sign element at sowing date.

Earth	Air	Water	Fire
144	289	229	241

TABLE 3

1978 mean radish yields per row (g) grouped according to sidereal moon-sign element at sowing date.

Earth	Air	Water	Fire
3.28	2.71	1.72	1.92

for fire and air sign yields than to earth sign yields; which would again tend to suggest that it is the signs rather than constellations which are operative.

The foregoing may not be in itself sufficient to justify biodynamic farmers in switching over to the sidereal zodiac, but is certainly something for them to consider. One would like to see more experimental work on this subject, in particular with sowings made specifically on the disputed boundary areas.

Postscript on Statistical Validation

Theory predicts that a particular element group will give maximum yields and the opposite element group will give minimum yields. So a t-test may be used to test whether the difference between the means of these two groups is statistically significant.

For the 1977 results, the two means are 320 ± 77 (n = 5) and 145 ± 125 (n = 6). This gives t = 2.7, which is significant at the 0.025 level.

For the 1978 results, the two means are 3.28 ± 1.7 (n = 18) and 1.72 ± 1.1 (n = 21). This gives t = 3.4, which is significant at the 0.001 level.

REFERENCES

1. "Zodiac Rhythms in Plant Growth", Mercury Star Journal, Easter 1978.
2. M. Thun, "Anbauversuche uber Zusammenhange zwischen Mondstellung im Tierkreis und Kulturpflanzen" in Vol. 1 & 2 of 'Lebendige Erde', Darmstadt, 1973.
3. U. Abele, PhD Thesis, University of Giessen, West Germany (1973).
4. U. Graf, PhD Thesis, Zurich Technical College (1977).

For further details about signs and constellations, see "The Sidereal Zodiac", by Robert Powell and Peter Treadgold (Anthroposophical Publications, Temple Lodge Press, 51 Queen Caroline St., London W6.). (1979)

Books & Journals

THE PHYSICAL AND THE PHENOMENAL

G.A.Wells, Goethe and the Development of Science 1750 - 1900, Sijthoff and Noordhoff, Netherlands (1978), 161pp.

H.B.Nisbet, Goethe and the Scientific Tradition, Institute of Germanic studies, University of London (1972), 83pp.

It is not an accident that the most successful of Goethe's scientific studies should have been the theory of colour. Certainly he gave more time and attention to it than to any other field. But this is not the explanation. He was attracted to colour precisely because the abstract distinctions which were so alien to his temperament have little or no purchase on it. The study of colour is both psychological and physical, and the distinction between objective stimuli and subjective states of consciousness can be sustained in it only with the greatest difficulty. The stimulus turns out to be practically the entire visual field; and no doubt we shall soon discover that the response involves, perhaps even is, the entire organism.

Goethe is acknowledged by experimental psychologists of colour as one of the founding fathers of their science. (He is apparently responsible for subsequent interest in after-images, and invented this name for them.) His aphorism that the thinker who strives after cause and effect makes a great mistake since they together make up the indivisible phenomenon is a comprehensible saying for colour theory, but much harder for a science such as mechanics or astronomy which has no psychological component (1).

Friedrich Waismann asks in the Principles of Linguistic Philosophy (2), "What then is the problem solved by this (Goethe's) idea?" and answers, "It is the problem of synoptic presentation." The claim that synoptic presentation is explanation is convincing in the case of colours, less so in the case of something, e.g. an organism, which is not completely phenomenal, and so is more strongly tied into the causal schema of spatio-temporal events. Goethean precepts will be hardest to apply in science where the physical cannot be completely specified phenomenally (3). By the same token, they will be most successful where the phenomenal cannot be completely specified physically, in the study of imagery and colour and form, e.g. in biology.

In his sensitive and balanced study H.B. Nisbet, a Germanist at the University of Bristol, shows how several traditions merged in the scientific mind of Goethe - Neo-Platonic, Empirical, and Rationalist. The "archetypal plant" originated in the first of these, the approach to colour in the second. (Only "real phenomena of the senses", which the archetypal plant, to

Goethe's chagrin, proved not to be, provide genuine explanations. Or was it just that the archetypal plant turned out not to be physical? At any rate Goethe didn't find it in Italy.) The "primary phenomenon" is "one of the great syntheses of the older Goethe's thinking"; it is simultaneously an idea and an empirical phenomenon.

The unity of man and the world assumes many different forms in Goethe's scientific thought; and only where he is writing within a consciously Baconian framework (as for a time he did) can it be retrieved with such phrases as "No abstract theory" or "Observe phenomena" etc. Goethe embraced numerous and splendid Leibnizian, Platonic and other metaphysical abstractions. His use of them is powerful not because they ceased to be abstractions in his mind (although they did) but because a supreme intelligence and talent for observation transformed them and made of them lively and enduring objects of scientific and poetic interest. As for Newton, Goethe's objection to him was much more than a shallow empiricism.

Professor Wells is a geologist turned Germanist, teaching at the University of London, and his book contains much useful detail and summary. It prompts the reflection that there cannot be a doctrinaire Goethean science or methodology; but there is a genius called Goethe whose scientific work will remain a source of inspiration in a variety of fields. (A friend just sent me an article which he published in Nature one of whose central thoughts reflects Goethe's observation that death is Nature's way of ensuring an abundance of life (4).) The best I can do to commend Wells' book is to reproduce part of the Table of Contents:

3 Geology

- (i) The classification of rocks and the stratigraphical picture.
- (ii) The relation of granite to other rocks.
- (iii) Pudding stones as precipitates.
- (iv) The importance of time in geological controversy.
- (v) The basalt controversy.
- (vi) Vulcanism and mountain building.
- (vii) The temple at Pozzuoli, the Luisenberg granite blocks, and the North German erratics.
- (viii) Conclusion: Goethe's method.

There is a huge and interesting literature (5) on Goethe's scientific work, ranging from Steiner and Schopenhauer to Helmholz and Heisenberg (the latter's 1941 paper "Goethean and Newtonian Theories of Colour in the Light of Modern Physics" incidentally very favourable to Goethe). Goethe and the Development of Science 1750 - 1900 is a neutral and careful survey of some leading Goethean themes. Those interested in Goethe's science, what has become of it and why, should definitely read it. Its deficiencies are mainly philosophical, for example the uninformed and leaden argument against Goethe's brilliant anticipation of the twentieth century view that the propositions of mathematics are in some sense analytic, and not synthetic:

> "Mathematical proofs are really only detailed demonstrations that the entities linked by them were already there in part and whole...mathematical demonstrations are expositions and recapitulations rather than arguments."

(From "The Experiment as Mediator between Object and Subject" (6))

Goethe has a lovely answer to Mill's objection, pressed by Wells, that the thesis that mathematics is analytic would make its utility inexplicable. A propos of something else he says (7),

> "All the countless operations of mathematics can be reduced to a few formulae, as the compass shows us the way from end to end of the oceans. It helps us through the most intricate subterranean labyrinths; it aids us in finding our way through difficult country, and in fact its uses are many and magical, because it obeys immutably a simple law, which applies to the whole of our planet, indicating everywhere a Here and a There, which the human mind grasps, uses, and applies in endless ways."

Readers of Science Forum will perhaps enjoy Nisbet's book more than Wells' . It is more literary, more smoothly written, and more sensitive metaphysically. And some powerful metaphysics is required to assimilate the physical to the phenomenal or vice versa. We would do better to retain two separate but overlapping systems of explanation.

Notes and References

(1) It is interesting that modern science started with astronomy, whose objects are farthest removed from man. Goethe confesses (Eckermann, Conversations with Goethe, Everyman (1970), p.171) that he "attempted natural science in nearly every department: nevertheless my tendencies have always been confined to such objects as lay terrestrially

around me and could be immediately perceived by the senses. On this account I have never occupied myself with astronomy; because there the senses are not sufficient - instruments, calculations, and mechanics, which require a whole life, are needed, and were not in my line." (My emphasis)

(2) Macmillan, London (1971), p.81 .

(3) Would it be possible to show that in the physical sciences where mathematics is most successfully applied it performs an essentially Goethean role - providing not causal explanations but a synoptic view? Even so, there will not be one Goethean methodology ("exact imagination" is perhaps as much a talent as it is a method) which can be trained indifferently on different kinds of phenomena.

(4) Rupert Sheldrake, "The Ageing, Growth and Death of Cells, Nature, Vol.250, (1974),pp.381-385. Se also "Death" by the same author in Theoria to Theory Vol.7 (1973), pp.31-38 .

(5) For some of it see Stanley L. Jaki, "Goethe and the Physicists", American Journal of Physics, Feb. 1969.

(6) Cf.Wittgenstein, Tractatus 6.1262, "Proof in logic is merely a mechanical expedient to facilitate the recognition of tautologies in complicated cases."

(7) "Contribution to Optics" in M.Schindler, Goethe's Theory of Colour, New Knowledge (1964), p.160.

Jonathan Westphal

NUCLEAR DISASTER IN THE URALS

by Zhores A. Medvedev
Angus and Robertson, 1979, £5.95 .
A noted Russian scientist pieces together the evidence for the extensive devastation, contamination and loss of life that occurred when a nuclear waste disposal area blew up 'like a volcano' in 1958. The details, meticulously collected, seem to emphasise the elusive, insidious and (often delayed) lethal aspects of this form of energy. The elements of secrecy and deception are ever-present: news of the event was suppressed not only in Russia but also, until 1976, in the West.

Hedley Gange

THE CYCLES OF HEAVEN

by Guy Lyon Playfair and Scott Hill,
Pan Books, 1979, £1.20 .
The authors first examine the scientific evidence for cosmic influences in man and earth. The relationship between 'homo electromagneticus' and the 'electromagnetic web' that surrounds him is then considered. Other subjects dealt with include: earthquakes, biorhythms, dowsing, the Kirlian effect and 'quantum mechanics and consciousness'. The book contains a wealth of information and references, but anthroposophy is not mentioned.

Hedley Gange

THE WARMTH COURSE

14 lectures by Rudolf Steiner, Stuttgart, March 1920. Published by Mercury Press, Spring Valley, New York, Easter 1980 (115pp., $12.50)
A warm welcome must be extended to this book, which, as far as I know, is the first English version of Steiner's fundamental "heat Course". Until now, only typescript copies were available. What has prevented publication of these important lectures for so long? The typescripts were riddled with mistakes, and several inconsistencies are apparent in the text. These can only be resolved by concerted study, and it is to facilitate this that Mercury Press have taken the brave step of publishing, mistakes and all. In fact, many of the errors which occur in the early typescripts do not, thankfully, appear here. And most of those that do should be capable of resolution by the thoughtful reader. For example, on p97 we read, in connection with super-imaginary numbers, "...they are readily handled mathematically...", which should be "...they are not readily handled mathematically...". This is obvious from the context.

Briefly, the course explores the nature of heat as an entity in its own right, not as merely the effect of vibrating particles. The 'scale of nature' is developed, in which heat occupies a central position between the earthly elements and the cosmic ethers. It is, nevertheless, a practically - based course, making full use of many standard physics experiments to approach the central theme. It is an important challenge for individuals and scientific groups today to gain a clear understanding of these lectures, possibly also developing new experiments to supplement those available to Steiner in 1920.

Howard Smith

MATHEMATISCH-PHYSIKALISHE KORRESPONDENZ

Dornach. No. 116 (Summer 1980).
The main article in this issue deals with the cosmic nature of the motion of a vortex. This is largely descriptive, with references to Rudolf Steiner, but basic formulae and numerous diagrams are included. An article entitled "A life in the service of geometrical astronomy" gives an appreciation of the work of Wilhelm Kaiser, on the occasion of his 85th birthday. There is also a report on the method of constructing models of solid figures out of wire as developed by Albert Kaiser of Stuttgart: an icosahedron with an inscribed star-dodecahedron is taken as an example. Shorter items include reviews of Heidi Keller von Asten's book on the Platonic solids (Wandlungen - Freundschaft mit den Platonischen Koerpern, 1980) and a German edition of Jerry Mander's book, 'Four Arguments for the Elimination of Television', 1979.

Hedley Gange

DIE DREI

October 1980 issue. ("Die Drei" is published monthly by Verlag Freies Geistesleben, Stuttgart.)
This issue contains one article of scientific interest: "Ein offenbares Geheimnis - Die Metamorphose beim Wachstum von Kristallkugeln" by Guenter Nitschman. It describes experiments performed some 40 years ago in which spherical crystals were allowed to grow in a saturated solution. The metamorphosis of the shape as the original crystal grows is described in the article, and interpreted anthroposophically.

Matthias Klimm

ELEMENTE DER NATURWISSENSCHAFT

No. 30 and 31 (1979). (Published twice yearly by Philosophisch-Anthroposophischer Verlag, Goetheanum, Dornach.)
Issue No. 30 contains the following main articles:
Eckard von Wistinghausen: The relation between chemical composition and outer form for carrots is studied, with the object of clarifying the concept of 'quality'. Three different sowings at monthly intervals were used, each sowing being subdivided into ground prepared by three different varieties of compost. Both sowing time and type of manuring were found to affect the course of growth, and correspondingly the composition (% dry matter, nitrate nitrogen, protein nitrogen, pure protein, sugar). "Quality" must take all of these - and more - into account.
Peter Goedings: An article on the Aristotelian categories, and Aristotle's concepts of movement, substance, and being; their relevance to modern scientific method is shown.
Jochen Bockemühl: The 'sense of direction' of animals is described as the working of the etheric body.
Henning Kunze: A critique of the book, "The Self and its Brain" by Karl Popper & John Eccles (1977).

Issue No. 31 contains the following:
Arne von Kraft: An experimental study of the symmetry of formative forces operating in the amphibian (salamander) embryo; a technique is used in which two individuals are made to coalesce in the earliest stages of their development, and the resulting double-organs are then studied. The individual organs show asymmetry, but in the joined pair there is mirror-plane symmetry, suggesting that the individuals are now subject to a super-individual organising agent which restores equilibrium by producing a higher symmetry.
Renate Rautenstrauch: This article deals with the "drop-picture method" (Tropfenbildmethode) of Theodor Schwenk. The morphology of the vortices comprising the fluid flow forms ("drop-pictures") is studied and three main form elements are identified: a contracted, closed form, a loose, open form, and a rounded, harmonious form between these two. The interplay of these three through the course of the year is plotted, indicating a possible relationship with lunar phases.
M. Wilson & R.W. Brocklebank: German translation of "Two-Colour Projection Phenomena" (see Journal of Photographic Sciences, Vol. 8, (1960), p141 - 150).
Jochen Bockemühl: A phenomenological study of the kingdoms of nature from the point of view of spatial orientation; this latter, when taken in conjunction with the elements and ethers, is shown to be an important key to understanding the essential quality of each kingdom. To mention but one example, Bockemühl shows how, just as the vertical direction is fundamental to the gesture of the plant kingdom, so is the horizontal related to the animal kingdom. But such a bald statement of "results" does not do justice to the subtle arguments, as wide as they are deep, which he employs.

Howard Smith

MERCURY

No.3, April 1978. This is the journal of the Anthroposophical Therapy and Hygiene Association (U.S.A.), published on an occasional basis by the Mercury Press (241 Hungry Hollow Road, Spring Valley, New York 10977).
This issue contains an article by F. and G. Husemann on "The Hydraulic Ram and the Movement of the Heart". Although Rudolf Steiner was adamant that "the heart is not a pump", it is clear that this statement is not intended to deny that the heart has indeed some "pumping" action. It seems that, of all pumps, the old hydraulic ram - invented in 1796 - most closely approaches the complex movement of the heart; a fact to which Steiner himself drew attention. This article gives a clear explanation of the mechanics of the ram, which differs from modern pumps in that it utilises none other than the force of the water itself in pumping. The heart is also described with the help of diagrams. Further, and most significantly for anthroposophists, the place of flowing liquid - rivers - in the household of nature is likened to the action of a great "heart". This is developed in detail for the Rhine and Danube, which are likened to the systole and diastole at the point of their junction. Finally, the role of the heart as a sense organ is discussed; the hydraulic ram compares with the "external" function of the heart, but this organ is also the basis of our perception of spiritual warmth, and with it, ego-consciousness.

Howard Smith

NEW SCIENTIST

18th September, 1980, p844, "A Sense of Magnetism", by R. Baker.
This article will interest many readers of Science Forum, as it claims to have discovered a new sense in man - a magnetic sense of direction. Blindfolded subjects removed from familiar surroundings can indicate the direction home with statistically significant success rates. The magnetic nature of the perception is evident, since it can be scrambled by strong magnetic fields which outweigh the earth's field. A neat piece of research.

But some readers may be irked by an undercurrent in the article: the discovery is used to stress the identity of man and animal (since it is now believed that the homing instinct of some species is magnetic in nature). This is at best a dubious syllogism, and is stated no less than three times in the article (e.g. "...this new facet of the human animal..."). Even the front cover of the issue shows a cartoon caricature of a half-man, half-bird. All innocent fun perhaps? The October 9th issue of the same journal (p95) summarises a piece of research on the effect of play deprivation on primary school children. The work is published in full in Vol. 28 of the journal, 'Animal Behaviour'.

Howard Smith

The Role of Thinking in Science

by Nick Thomas

An empiricist maintains that significant matters of fact can only be grounded in sense perception. The criterion employed may be a strong verifiability criterion as adopted by the early positivists, in which allowable statements, called basic or protocol statements, can be constructed by some unimpeachable procedure from sense perception, or it may be a falsifiability criterion, in which absolute truth may never be inferred but absolute falsity can. The severe difficulties in arriving at a so-called "strong" verifiability principle led Ayer to propose a weak one (see "Language Truth and Logic") which rendered the whole process of constructing protocol sentences to some extent hypothetical rather than unimpeachable. This represents a big step away from absolute reliance on sense perception. The verifiability approach requires the basic statements of matters of fact to be determined first, and only then does it allow logical deduction to be made from those statements.

Science does not proceed this way by and large, but rather depends on the process of forming and testing hypotheses. A hypothesis, once formulated, allows consequences to be deduced which may then be tested by experiment and observation. Karl Popper proposed the principle of falsifiability for a criterion of what is scientific as a practical way of allowing the normal process to continue. As a result the possibility of knowing truth is ruled out because what is positive is a hypothesis, what is certain is the disproval of a hypothesis, and what is adopted as current theory is a more or less well corroborated one.

The virtue of an empirical approach to science is that it renders a comfortable existence in cloud cuckoo land impossible since it insists that observation is essential: reality cannot be derived from mere thought and speculation. Its drawback lies in ignoring a source of empirical data it cannot dispense with: thinking itself. The role of thinking is relegated to a mere ordering of observations based on tautological inference.

The first fact to note is that scientific endeavour is impossible without thinking. It is an indispensable instrument which alone must perforce be accepted in a naive-real sense, for if its efficacy is doubted then all scientific activity must cease. Indeed such doubts must themselves be the product of thinking. Since brain processes are also examined with the aid of this instrument, to say that it is no more than a product of them is to reason in a circle.

A second fact to note is that no basic statements can be derived from sense perception alone: only by thinking about such percepts can any statements at all be derived. It is almost possible to write an equation: percept plus thinking yields statement (or hypothesis or theory). The empiricist argument that sense perception is reliable - because it is sense perception that reveals errors - is only a half truth: thinking alone can doubt the result of sense perception and thereby prompt the search for further data.

The need for observation is not being questioned, the theory that all facts can be spun out of thought alone is certainly not being propounded, but a true evaluation of the role of thinking is being sought. This is badly needed, for it underlies the whole problem encountered in finding a suitable criterion for significance, which in any case would have to answer to the ultimate court of appeal of thinking itself.

Rudolf Steiner pointed out (see "The Philosophy of Freedom") that thinking is the only process we experience which may be applied to itself. This is most significant, for it means that empirical facts are obtainable from the observation of thinking itself. Hence the earlier statement was made that thinking is a source of empirical data that has been ignored by the empiricists.

Naturally, objections to introspection

necessarily occur at this point. But the real danger of introspection comes when it attempts to explore feeling, not thinking. The study of thinking must be the most exact of sciences since all other sciences depend upon it. Thinking alone reveals facts like "2 + 2 = 4". Such truths have nothing whatever to do with feeling. The whole study and development of logic results from the application of thinking. To accept logic and deny the objectiveness of thought is like driving a car while denouncing thermodynamics! The result is the view that all logic is tautology.

If we step back a pace and look at "2 + 2 = 4", or at logical deduction, then a movement of thought is clearly apparent in each case which is superior to the tautological aspects (cf. the discussion of the imputed circularity of syllogisms). That movement is only apparent, however, by thinking about thinking.

The data ordinarily supplied by thought is in the form of concepts. Consider relatively subtle concepts like "open set" in mathematics, or "line complex" in geometry, or a complex number in arithmetic. Admittedly these concepts may be arrived at by "generalisation", but what does that mean? What is this mysterious process of generalisation? Science has long and rightly eschewed all explanations which are untestable and infinitely modifiable (such as "vital body" or "magic"). The supposed process of "generalisation" falls in this category, unless it is rendered precise by the observation of thinking. We observe that having seen many circular objects (as we would say after the event) we acquire the concept "circle". We can also observe that the concept "circle" is only acquired if those round things are thought about. It is commonly accepted that a perfect circle is probably non-existent to sense perception, so where does the notion come from? Indeed how would a perfect circle be recognised as such if it was perceived? The answer is under our noses, and therefore often out of focus: thinking derives the concept just as the senses supply the percepts.

The long philosophical discussions that have taken place on the nature of sense data show that their status in the realm of reality is not easily clarified. Without the application of thinking to what we perceive, our percepts (or sense data) remain a bundle of disorganised phenomena that merely confuse us. The application of thinking organises them for us, often by producing a law of nature which embraces them. Such a law comprises one or more concepts which, however, are in themselves no more real than sense data. The union of the two yields reality. Both thinking and observation are required to obtain knowledge. No scientific advance made so far could have rested solely on perception or solely on thinking. The essence of observation, indeed, is that it is thought-directed perception. A layman looks at the stars, and notices nothing new, while an astronomer would at once spot the sudden emergence of a new object. He has previously thought about his percepts while the layman (in this example) has not. Thus he can observe, while the layman only sees.

The next step is to see that thoughts are active forces in nature. That step cannot be made, though, without the willingness to observe thinking itself. For those reluctant to take this step, it is worth noting that the present concepts of force and field in physics, which are supposed to determine natural events, are no more probable an explanation than is the presence of thinking, in the form of, for example, ordering or organising agencies (although it is not suggested, at this stage, that the concepts of force and field should be dispensed with). There is one over-riding advantage to supposing that thought operates in nature, and that is that there is evidence for it: it operates in human beings who are a part of nature! We could envisage the inertia/force polarity being supplemented by a chaoticising/organising one, the former residing in the second law of thermodynamics and the latter in the effect of thinking.

The charge of metaphysics may now seem overdue. Against this it may be observed that a metaphysical belief in the operation of thought in nature is not being advocated, but an empirical one based on the observation of thinking itself. A truly objective scientific method along these lines was advocated by Goethe, who wanted to observe not merely outer appearances but active thoughts (ideas) also. In a sense he wanted to be empirical in the realm of ideas as well as in the realm of the senses. This contrasts with empiricism based on the falsifiability criterion which has first to invent hypotheses and then to test them. The method of Goethe proposes to perceive the active laws of nature through an accurate observation of phenomena. The intention is to read nature like a book rather than presuppose the plot. This is achieved by

observing a series of phenomena accurately (e.g. successive weather conditions) and then metamorphosing the separate pictures into each other as an inner exercise of thought. The thinking process required to do so is then observed. The result is a growing ability to perceive the corresponding objective thought processes occurring in nature. In this way the laws of nature are discovered empirically rather than hypothetically. To be successful, both accurate observation and accurate thought are essential - in other words an all round "ideal empiricism".

What help does this provide in the search for a criterion of meaning? The early positivists sought to reduce all statements to a logical synthesis of protocol sentences based on sense perception, while Popper seeks to provide a falsifiability criterion. In these and other cases it seems that an essentially automatic means of distinguishing significant from meaningless statements is sought, i.e. one that is in principle reducible to a mechanical implementation (notwithstanding the practical difficulty of doing so, say, by computer). It must not, apparently, depend upon the fact that a particular person assesses the meaning of a statement, or even that a human being does. What is sought is a formula that may be applied with the minimum of judgement on the part of the individual. This is, presumably, to combat human frailty!

Evidently any criterion we do accept is a product of thinking. If it is formulated so as to exclude any further need for creative thought or judgement, then it is an automatic one. On the other hand if thinking has the fundamental role already claimed for it, then each judgement of meaning must rest on thinking, because it is only through thinking about things that they are ever supposed to have meaning or not. The wish to abrogate responsibility for inwardly standing for or rejecting each new statement leads to the search for an automatic criterion. And that abrogation is granted spurious justification by appeal to the frailty of human judgement. Popper says: "We must distinguish between, on the one hand, our subjective experiences or our feelings of conviction, which can never justify any statement (though they may be made the subject of psychological investigation) and, on the other hand, the objective logical relations subsisting among the various systems of scientific statements, and within each of them". Yet in reality the acceptance of a theory to any degree remains an individual act of judgement by each member of the scientific community concerned. The reality of this is reinforced by "crisis" (as depicted by Kuhn in his "The Structure of Scientific Revolutions") in which it is increasingly difficult to retain a paradigm, and yet often the committed judgement of the community involved retains the current paradigm against the mounting evidence for as long as possible. The Darwinian-like struggle for the survival of the fittest paradigm described by Kuhn is far from an automatic application of a criterion of meaning! Popper's attempt to relegate this to psychology is an example of a trend in science to eliminate the human being.

How, though, do we distinguish that which is scientific? Exact thinking alone can do this. We may expect our concept "scientific" to evolve, as it has in the past, in which case a once-for-all formula is unlikely to stand for long. Science remains a human activity conducted by human beings, for all their frailty. Any exactness we do have rests on precision of thought. What, after all, determines for us that measurement is an exact and reliable procedure? What determines that logic is a trustworthy tool? This is not to say that all knowledge is spun out of mere thought. It is to say that meaning is not the affair of a disembodied automatism, but of the human being who needs it. His only reliable tool is thinking, which itself determines the need for exact observation as well as precise thought.

Correspondence

TOPOLOGY, NUMBER THEORY

I have constructed two solids related to the well-known Möbius surface; both are rings with square cross-sections, one has two sides and two edges, the other only one side and one edge. The edge of the second ring is represented by the equations

$$\rho = a + b\cos(\phi/4)\ ,$$
$$z = b\sin(\phi/4)$$

in cylindrical coordinates ρ, ϕ, z. I find no mention of them in books on topology. If anyone knows that a description of them has been published, I would appreciate a reference, otherwise a complete description may be worth publishing.

I would also like to know to what extent the following subjects in number theory have been investigated:

1)Relations between three different powers, such as $3^5 + 10^2 = 7^3$; as the theorem that $10^n + 1$ can never be a square, and similar theorems, also belong here.

2)Formulae such as 5^{2^n} and 6^{5^n} for automorphic numbers

Concerning the problem of representing prime numbers p_n as an analytic function of the number n: I presented some results to a scientific society 20 years ago; the manuscript was neither rejected nor published, but filed away with the instructions "Wait for the second part". The chief formula in the manuscript was

$$p_z = p(z) = \frac{1}{(-z)!}\int_0^\infty P(-t)t^{-z}\,dt$$

$$P(t) = \sum_0^\infty p_{m+1}\frac{t^m}{m!}$$

Is anyone interested in a summary of these results?

P. Olijnychenko
(Address supplied)

STANDARDS IN SCIENTIFIC PUBLICATIONS

I believe it is vitally important that, from the start, the new journal adopts the standards normal in scientific publications today and not the standards - or rather total lack of standards - typical of most publications on Super-nature.

A Goethean approach can be so revealing that when it is applied to a new field by someone who possesses only an average scientific education in that field, they feel they are in virgin territory; as, in a very real sense, they are. It is scarcely surprising if they then feel they must communicate their discoveries at once, forgetting that the field will almost certainly have been painstakingly explored by many investigators over many years and that few of those investigators will have been wholly lacking in imaginative insight. So it is not surprising if the 'Goethean' studies, when published, turn out to be unoriginal or superficial.

Some work of this type inevitably will be published without being scrutinised by an anthroposophic editor. However, even when it has come out under an anthroposophic imprint, normal scientific discussion within the Society has apparently usually been regarded as taboo. How else could so many terribly misleading statements survive reprinting, let alone second editions? For example:

1)crystallisation experiments with metal salts during planetary conjunctions where the patterns changed within a few minutes on either side of the moment of conjunction yet the sequence remained unaltered when a new almanac was used, which, unknown to the investigator, used a different definition of a conjunction ('nearest approach' replacing 'both on same azimuth' or vice versa - I have not personally checked this example);

2)weight-change experiments indicating transmutation of elements in plants given prominence and treated as ordinary experiments although they have never been successfully repeated;

3)the erroneous idea that all meteorites

have their radients in Scorpio used as a basis for an elaborate theory.

[The writer then gave examples, in some detail, from the fields of ecology and sedimentary geology. - Ed.]

The Anthroposophical Society has always had scientific research workers of the highest calibre and integrity and it is encouraging to see their published researches read and quoted so widely. However, much remains to be done; by authors, editors and also by the general anthroposophical readers who, inevitably, are the writers principal audience.

(Extract of a letter)

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STEINER'S 'LIGHT COURSE'

Following the last science conference, a number of us in the Nottingham-Ilkeston area founded a small group to maintain our interest in anthroposophical science. We have stumbled through a number of topics, most notably the 'Light Course', which is the reason for this letter. Over many weeks of profound head scratching and heated debate, we found that there were certain stumbling blocks which could not be overcome despite repeated assault.

We have distilled out three questions, so that readers may share our problems and perhaps offer some help. The first question is fundamental and applicable to the methodology of the whole course of lectures, while the other two are more specific.

1) The nature of the Goethean method. If the method finds "explanation" in phenomena without resorting to concepts not given in the observation, then why does Dr Steiner use an apparently deductive argument to link elements which are immediately perceptible to others which are not? For example, in the discussion on interference:

> "Here, so to speak, a hole has arisen in the light. The light rushed through; a hole was made, appearing dark. And as an outcome of this 'hole', the next body-of-light will go through all the more easily and alongside the darkness you will have a patch of light so much the lighter." (Page 4.6; our emphasis)*

Is this a genuine deductive argument, or is it simply our failure to see what for him was "obviously perceptible" ?

2) As a concrete example of this sort of argument (and one which we found particularly baffling), consider the way Steiner "explains" (accounts for) the production of coloured fringes when a beam of light is passed through a prism.

He introduces the notion of "dimming" which is caused by the light passing through a physical medium. This is quite acceptable. But then he ascribes properties to this dimness (e.g. raying after the light, being deflected by the prism, etc.) which are not perceptible in the primary phenomena, and then uses them to account for these phenomena (i.e. the coloured fringes) . (Page 2.8)

3) There is an apparent inconsistency in the accounts Steiner gives of two seemingly similar phenomena:

> a. a beam of light, deflected by a prism, into which an observer looks.
> b. the apparent displacement of an object at the bottom of a basin of water when looked at from an angle.

In the first case, the apparent displacement of the source of the light is accounted for by the interposition of the prism in the beam of light; in other words the effect is caused by light and prism alone (page 4.2). In the second situation, the apparent foreshortening is ascribed to the resistence offered by the water to the sense of sight; i.e. the effect is caused by an interaction of the physical circumstances and the observer's perceptual activity. (page 3.6 - 3.7)

Yet it would appear that these two conditions are very similar; indeed if we replaced Steiner's coin at the bottom of the basin by a source of light with a circular aperture, then the two would be identical. We can see no reason why a hypothetical soul process should be invoked for the one account when a perfectly clear physical explanation is used for the other.

As Steiner frequently attributed the difficulties of his audience in understanding his lectures to the effects of their education, this could equally be true of us. Is this the case, or is there some key to mastering this whole lecture course which we have failed to grasp?

We look forward to hearing from readers.

(*Page numbers refer to the 1977 Steiner Schools Fellowship edition.)

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GOETHE, PLATO AND ARISTOTLE

May I comment on 'Goetheanism and Spencer Brown's Laws of Form' by Nick Thomas? One could get the impression that Goethe's opposition to ideas developed from Plato was something new, as Aristotle is not mentioned (p7). It was Aristotle, Plato's most distinguished pupil, who 'saw' - or should one say 'experienced' - the relationship between matter and spirit very differently. Plato described a world of ideas, beyond the world of matter in which only imperfect reflections of these ideas could be found. (So Plato described artists, poets, etc. as producing copies of copies, and therefore being at a further remove from reality, whereas for Aristotle the ideas inhered in the things, and the artist expressed or interpreted these ideas, freed from misleading accidentals. Therefore, for Aristotle, poetry was more philosophical than history.) The Goethe - Schiller controversy is in some ways parallel to the Plato - Aristotle.

Perhaps, also, I may add to the footnote to 'The place of Chemistry among the Sciences' (p9)? Scattered through Steiner's writings, from 'Theosophy' onwards, are descriptions of the difference between percepts and concepts; percepts, the receptivity of the sentient body, concepts, the activity of the sentient soul. Much wisdom for scientists is contained in 'The World of the Senses and the World of the Spirit'*

Good luck to your venture. I look forward to seeing future issues.

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(* obtainable from Rudolf Steiner Bookshop)

POINT OF VIEW

I hope very much that 'Science Forum' becomes a viable magazine; there are so many themes that need airing.

May I make some minor criticism about the way some authors express themselves? Some of the phrases I find unacceptable are:

page 11: 'From an anthroposophical standpoint...'
page 19: '...in the anthroposophical world view...'
page 18: '...the anthroposophical way of looking at nature...'

These expressions seem to imply that there is something special and even something sectarian about the anthroposophical world view; indeed the scientist is after truth and may use this or that model as a crutch or aid to grope his way towards it. Many of Steiner's descriptions no doubt are greatly helpful but cannot or should not constitute a 'world view', a sort of finished and closed system, incapable of modification or even contradiction if necessary. I do not accept that there is 'an anthroposophical standpoint'; we each have our own and may rely to a greater or lesser extent on what Steiner has said.

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SCIENTIFIC HYPOTHESES AND ETHERIC FORCES

People sometimes question the wisdom of seeking scientific phenomena relating to etheric forces. Rudolf Steiner pointed

out that the etheric or life forces can only be studied directly with the aid of exact supersensible perception. Is the search for phenomena, then, vain?

Guenther Wachsmuth draws attention, in his book 'The Etheric Formative Forces in Cosmos, Earth and Man'*, to the nice distinction Steiner drew between justified and unjustified hypotheses. A hypothesis is justified when it may in principle be replaced by direct observation.

To adopt the existence of etheric forces as a scientific hypothesis is justified on this basis, provided it is accepted that in principle exact supersensible perception of them is obtainable through special training.

If phenomena may then be predicted with the aid of this hypothesis, and verified by scientific experiment, the undertaking would seem to be justified, I would welcome further comment on this view.

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(*Anthroposophical publishing Co., 1932, p18)

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"A Lemniscatory Path for the Earth", by Dr. Martin McCrea

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