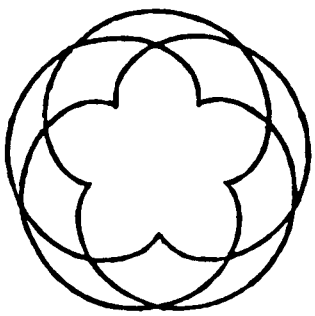
SCIENCE FORUM



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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

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.

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Editorial

The interests of the Science Group of the Anthroposophical Society in Great Britain continue to expand and diversify. The January 1982 Conference of the Group, which we report in this issue of *Science Forum*, discussed several subjects which are ripe for further investigation and elaboration: Can a scientific framework for the study of the etheric forces be formulated? How does a modern doctor regard the circulation of the blood? Are the chemical elements less immutable than is generally supposed? Can a phenomenological approach to the study of light be systematically developed?

For those with an interest in mathematics, we have some new and penetrating thoughts on 'The Prime Number Domain—echo of what is individual in the world', as well as reviews of *Universal Forces in Mechanics* and *The Field of Form*.

There is a certain thrill about being present when a fundamentally new approach in science is expounded. Dr. Bockemühl's presentation of his 'New Perspective in Heredity', at a conference of the Science Group in May 1982, does not render obsolete the existing study of heredity, but it does show how it can be seen in a new light, against a wider background, as well as providing an entirely new point of departure for the understanding of heredity, based in the first place on an examination of the nature of the concepts and mode of thinking appropriate to the investigation of this realm. Limitations of space prevent an adequate account of the conference in this issue but we hope to include more on this subject in future issues. (Report on page 28)

We have much pleasure in publishing two preliminary reports of research projects being pursued by members of the Science Group with the aid of grants from the Margaret Wilkinson Research Fund. One concerns flowing forms and rhythms in water and the other the methodology of capillary dynamolysis. A third report discusses different approaches to the phenomenon of potentisation. Anthroposophy is deeply concerned with the realm of thought, but a vital element is to be found only in the field of experimental investigation—the discipline of physical reality.

Contributions to *Science Forum*

After four years of publication, it seems that the most practical arrangement will be for *Science Forum* to appear once a year, in January. If there is sufficient interest, it is intended to circulate to the members of the Group a, less formal, News Sheet at more frequent intervals. This will serve to maintain communication channels and discuss any items of interest, including social arrangements, conferences, etc., as well as facilitating the exchange of ideas of a tentative or informal nature on scientific topics. Contributions intended for publication in Science Forum will be welcome from February onwards. We will be glad to have longer articles, particularly, by the end of June: if this is not possible, a synopsis of a proposed article or report, with an indication of the approximate length, would be most helpful. In the period from September to December, the processes of editing (with associated correspondence), checking and printing tend to merge into the general heightened activity preceding Christmas. Articles, comment or criticism from anyone who is interested in the aims of the Science Group will be considered for publication.

Next Science Conference.

As mentioned in the News Sheet of October 1982 (sent to Science Group members), we had hoped to hold the next main conference at the end of May 1983. However, no response was received to the request for conference accommodation, ideas etc., and this date is now cancelled.

The next conferecne will now be held at Wynstones House, Gloucester, *from the evening of 30th December, 1983, to midday on 2nd January, 1984.*

Theme: we will address the end-product of reductionist thinking—the influential and all-pervasive theories of the atomic and sub-atomic realms. Such questions as the following can form starting points: Which observable phenomena underlie these theories? What is the validity of the theories, and how have they worked in the consciousness of the twentieth century? Are there alternative views of nature which do justice to the phenomena?

A full notice will be sent to members (and non-members on the mailing list) in the Summer, but it is not too early to send in offers of contributions now!

A reminder to members:

When making donations, please could you make cheques payable to 'Science Group of ASGB', *not* to individuals.

Our journal continues to cross the oceans and the continents; 'hands across the world' in the search for new ways of understanding the living and living ways of studying the lifeless.

The Physico-Chemical Basis of Capillary Dynamolysis

William Steffen

Capillary Dynamolysis (German: Steigbildmethode) was introduced by *L. Kolisko* in the 1920's and 1930's as a means of assessing the formative activity and biological state of organic substances. The method was seen as being capable of showing the life forces in organic samples such as plant extracts, foods and drinks, samples of blood and urine (*L. Kolisko* 1978). In some applications the method had medical diagnostic aims (*W. Kaelin* 1965), in others it was used as a tool for quality control in agriculture and food processing. A further field of application was the study of planetary influences on plant life (*A. Fyfe* 1967,1973,1978; *M. Engqvist* 1977). For the investigations summarised here we were concerned with the method as used by *A. Fyfe* (1967) for the study of plant materials over long periods of time.

Our method in short: From the plant material under investigation an extract is prepared and 1 ml set to rise in each of five sheets of filter paper. After the sap has dried, 2.5 ml of a reagent, most commonly silver nitrate ($AgNO_3$), or aurichloric acid ($HAuCl_4$), is applied to rise through three of the treated papers, usually resulting in a wealth of form and colour, particularly above the rising limit of the sap. Distilled water is set to rise in the other two papers. Evaluation of the tests consists in considering the form elements, the degree of differentiation and the rising height of the reagent (*Plate 1*).

Studying the experimental parameters

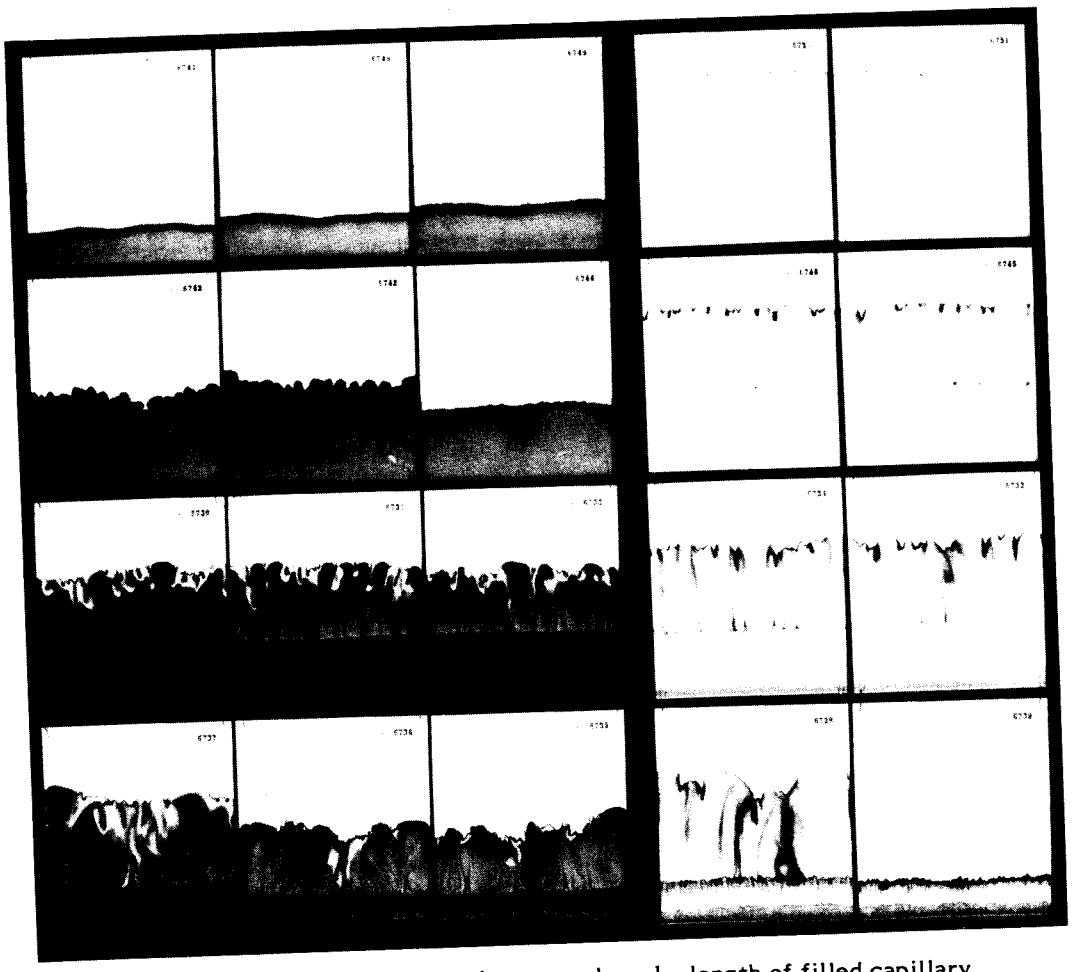
In connection with a research project at our laboratory, where it was essential to be able to use only very small amounts of plant material, it emerged that even a reasonably systematic handling of the method sometimes leads to considerably differing pictures representing the same material. We felt that the long process, from the picking of the material to the extract preparation and the setting of sap and reagent, needed to be examined very thoroughly before one could be sure that with a given test picture (or rather a number of equivalent test pictures) one had a reliable representation of all the pictures one could potentially make from a given plant material. According to the available literature such investigations had not, so far, been carried out in full.

First all quantifiable and semi-quantifiable parameters involved in the long technical process were clearly defined. Then aspects of repeatability were studied: Repeatability within picture series of the same extract, and within series of different extracts originating from the same sample of plant material. In this way a fair idea of the unavoidable experimental variability was gained. Then the criticality of the technical parameters was investigated by studying the impact of small variations of each on the final picture. All these investigations were carried out with leaf material of *Urtica dioica* (Great Stinging Nettle). The results showed that some of the parameters were rather critical, and considerations of repeatability by no means trivial (*W. Steffen* 1981).

Rising inhibitions and the physics of capillary flow

Following on from these investigations two considerations led us to study more closely the physical and chemical processes at work in this method. Firstly: By changing the process of extract preparation marginally in one or another way, or by varying the strength of the reagent used, CD pictures can often be obtained from one and the same plant material which show hardly any similarity, e.g. a well formed picture versus a picture with featureless, incomplete rising of the reagent. (We call the latter a 'rising inhibition'). Secondly: Rising height and form elements have been read 'phenomenologically' as an expression of the formative forces or formative tendencies in the fresh plant sap. In the light of the

Plate 1.



mentioned ease by which these features can be experimentally manipulated, the question arose as to how these features related to the formative activity of the sap on one hand, and to the physical and chemical properties of the sap and the test process on the other hand.

In this context only a few aspects of some of our findings can be described. More detailed accounts of our investigations are given in *W. Steffen* (1982,1983).

The fundamental process in CD is capillary flow. In phase 1 the extract, in phase 2 the reagent liquid rises through the pores of the filter paper. Capillary flow is the result of two inorganic processes: Capillarity on one hand, manifesting in rise or depression of liquids in narrow tubes, meniscus formation, wetting properties etc, and laminar flow on the other. Studying the capillary flow of liquids in glass tubes and porous substrates, particularly filter paper, *E. Washburn* (1921) theoretically deduced and experimentally tested the so-called *Washburn equation:*

$$\frac{dl}{dt} = \frac{r\gamma\cos\Theta}{4\eta l}$$

where l = length of filled capillary
r = diameter of capillary
γ = surface tension of the liquid
Θ = contact angle solid/liquid/air
η = viscosity of liquid

For r, γ, Θ, η, constant in time, integration yields:

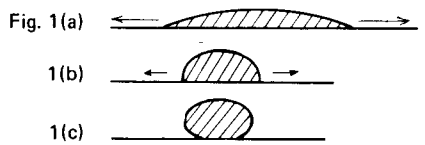
$$(2) \qquad l^2 = \frac{r\gamma\cos\Theta}{2\eta} \cdot t$$

The favourable, highly absorptive properties of filter paper are related to a low contact angle Θ=35° of most aqueous liquids on the clean cellulose fibres, and to their high surface tension γ. Accordingly water or any aqueous reagent used in CD rises fast through clean filter paper. The rise of plant extracts is usually considerably slower due to their higher viscosity and lower surface tension. Solids suspended in the extract are sometimes kept back at the bottom of the filter paper, leading to a reduced pore radius and resulting in a lower extract rising height.

Inhibited flow of the reagent, rising through a test paper which had a plant extract rising in

phase 1, is a recurring feature in CD tests of many plant materials. It was a particularly puzzling and challenging phenomenon, that often the inhibitory tendency increases with progressive dilution of the extract (see *Plate 1*). Since rising difficulties of the reagent in comparative series played an important part in the interpretation of test pictures in terms of 'formative forces' or 'activating power' of the sap (*A. Fyfe* 1967a), it seemed important to study these phenomena in more detail.

Our investigations showed that the dried plant extract in the filter paper presents the reagent with very different conditions with regard to the dynamics of the capillary flow, in comparison with clean filter paper. The effective contact angle Θ forming at the boundary of the dry 'lined fibres', the reagent and air is usually sharply increased to around 90°, which in terms of equation (2) means $\cos\Theta \approx 0$, i.e. slow advance of the reagent. This sharp increase in Θ can easily be observed by placing a small drop of reagent first on plain filter paper and then on a dry paper treated with a plant extract. In the first case the drop will spread and immediately penetrate into the sheet (*Fig. 1a*), in the second case it will take on the shape as in *Fig. 1b* and slowly, within a certain time lapse T, penetrate into the treated paper. In strongly inhibited test papers the drop will remain on the surface without penetrating into the fibres (*Fig. 1c*).



Some dried extracts, from leaf of Stinging Nettle e.g., are hardly re-soluble by most aqueous reagents. In these cases a scanning of the paper with the sessile drop test allows prediction, quite reliably, whether and where in the actual CD run the reagent will stop below the sap border. In tests of dried extracts which are partly re-soluble the organic solutes tend to reduce the surface tension of the reagent liquid front which indirectly reduces Θ and usually keeps it below 90°. Strong inhibitions in these cases are rather rare.

The *sizing process* in paper manufacture is a systematic application of the fact that water or ink penetration into sheets of cellulose can be prevented by raising the contact angle to values above 90° . In practice this is done by adding a rosin emulsion to the pulp which, in the dry finished paper lines the surface of the fibres with a mildly 'water repellent' film. This renders the paper suitable for uses such as writing or printing. Both sessile drop penetration as well as rising speed for ink or water through the treated paper, are established size test methods in paper manufacture (*J.P. Casey* 1960; *K.W. Britt* 1970).

Studies on pure substances show that at least the following groups relevant to plant saps increase the contact angle sharply once they have completely dried on the fibres and lead to inhibited capillary flow of aqueous reagents: proteins, waxes, resins and fatty acids. Other substances such as sugars and starch form low contact angles with the same reagents and generally allow a free speedy flow.

Form elements

Statements such as the following led us to study the question of the form elements:

> "The formation of the form elements cannot be grasped in terms of physics. No doubt there are differences in the rising speed of sap and silver nitrate solution in the second stage, but they cannot explain the process resulting in the observed form elements." (*M. Engqvist* 1977; translation: W.S.)

Again only indications of our findings can be given here.

In CD runs with silver nitrate alone on clean filter paper one can clearly recognise that in the course of the capillary flow the reagent separates near the front into a leading zone only containing water and at some distance, 'lagging behind', the front of the silver-containing zone; a phenomenon well known from paper chromatography. The form elements visible in the final picture arise through a complex differentiation of this flow of the reagent. Various physical and chemical processes, some of which will be indicated below, result in a differentiated and continuously changing speed distribution of the reagent flow across the test paper.

An important factor inducing differentiation of the flow is the sap border line. In many tests this border is clearly an obstacle to the flow of the reagent, and a break-through in only a number of separate locations leads to a non-uniform flow pattern above the border. Silver nitrate is being irreversibly deposited and later reduced to metallic silver, wherever the reagent temporarily flows along a near vertical border between two flow zones which originate from different places of break-through.

Another set of factors leading to a differentiated flow pattern is connected with the process of re-dissolving or releasing fractions of the dried substance applied in the first stage of the test. In a dry paper, first treated with refined sugar or apple juice, the reagent liquid front, right from the start, meets a considerable amount of free,

almost instantly soluble sugar. The steady increase in the viscosity near the reagent front leads to the phenomenon that the dissolved sugar gets 'channelled' into vertical, retarded streaks forming, in accordance with the *Washburn equation*, a zone of reduced rising speed (*Fig. 2a*). The continuous supply of reagent from below 'shepherds' these zones into elongated, drop-like shapes, while fresh reagent can continuously reach the liquid front in the 'cleared' advancing areas (*Fig. 2b*). The re-dissolving of the sugar is largely a matter of the silver-free reagent front. The latter therefore is mainly responsible for the formation of the speed distribution, whereas the silver-containing fraction of the reagent follows, embedded in this flow, 'circumflowing' the drop-shaped areas of low speed, i.e. high sugar concentration (*Fig. 2c*).

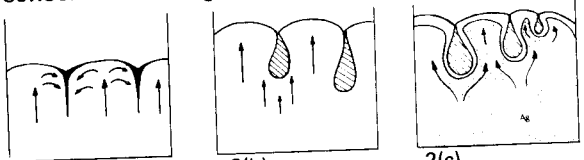


Fig. 2(a) 2(b) 2(c)

Not only an increase in viscosity at the reagent front leads to the accumulation of solutes in streaks or 'drops': any substances which in the course of the reagent flow are being dissolved or released are 'shepherded' into similar forms. Phenomena such as desorption and solute partitioning between mobile and static phase are involved here. Again the following silver-containing fraction usually avoids these areas, marking all temporary border lines of its flow. In these phenomena the continuous transition from analytical paper chromatography to CD can be found.

These and further observations show that the occurrence of the basic form elements in CD tests, including 'root-' and 'beard-like' formations and forms giving an impression of three-dimensionality, can be qualitatively related to physico-chemical processes and properties of the partaking substances. They usually occur in complex combinations. It should be stressed that the appearance of particularly expressive, 'beautiful' pictures is not restricted to tests on 'natural' organic substances. Some highly purified substances such as sugars or certain amino and other organic acids can lead to remarkably 'expressive' results.

Conclusions and critical assessment

From our studies it appears that the considered form of Capillary Dynamolysis is an inorganic, physical experimental situation. By this is meant that the processes and results (such as rising characteristics and form elements) can be related to physical phenomena in the sense *R. Steiner* (1886) describes the relationship between complex inorganic phenomena and Primary phenomena. The sap modifies and differentiates the capillary flow of the reagent by virtue of some of its physical and chemical properties in the dry state. The latter are intimately connected with composition, concentrations and balances of the metabolites, these of course being a result and reflection of the life processes in the plant organ up to and at the time of picking. Changes in those life processes, e.g. resulting in different balances between groups of metabolites (particularly sugars v. proteins), will lead to changes in the CD test pictures under otherwise equal test conditions.

From this certain doubts arise about some of the assumptions implied in the current way of 'reading' CD pictures. Various authors read pictures or variations in picture series 'phenomenologically' in terms of formative forces or formative tendencies of the sap, e.g. interpreting stunted or inhibited forms in the CD test as a 'lack of formative strength' of the sap. This approach is based on the assumption that the formative and differentiating impulses of the plant organ, carried by the fresh sap, modify in a direct way the flow process of the reagent in the filter paper. A thorough methodical study, which would have to precede any application, would need to investigate how the reagent flow, leading to the observed forms etc., relates to basic physical phenomena which are indispensable for the coming about of the picture. We can then ask whether this 'inorganic approach' is sufficient to describe the appearance of the picture. The results of our studies suggest that this is in fact the case. The *a priori* assumption that the Capillary Dynamic flow process responds to the formative forces of the sap seems to have led to the neglect of a thorough methodical investigation. Only such an assessment could show the potential and limits of a method and point us to useful applications. Undoubtedly a fresh plant sap is an infinitely 'rich' substance. Brought into an adequate organic context such as a soil (in making suitable preparations) or the human body (as medicines), these qualities can find a receptive 'sense organ' and can be active and creative. The set-up of Capillary Dynamolysis though appears to be receptive only to some of the inorganic aspects of the sap or other liquid under investigation.

We may at this point consider possible applications of CD: Since differences in the metabolic composition of different saps usually result in variations in the respective CD pictures, the

method may in various fields be used for consistency control, as has been done in the preparation of mother tinctures for homoeopathic remedies. The so-called Soil Chromatogram, a variation to CD introduced by *E. Pfeiffer* (1959a,1959b), points to a second field of application: an intimate knowledge of, and experience with a wide variety of soils, including their biochemical analysis, enabled *Pfeiffer* and his collaborators to empirically relate certain forms, colours and zones to features such as the biological state and the degree of mineralisation of the organic matter present. For each such application on a particular (plant) material extensive investigations would have to provide an empirical correlation between the features in the CD picture, the main metabolic factors relevant to the formation of the picture and the intimate perception of the plant organism in its stages of growth, rhythms and relationship to environmental conditions. CD might then be a useful tool in the context of quality control or basic research on plant development, though it would always have to be complemented by other methods and direct observation on the material in question.

Finally a comment on research into the reflection of planetary constellations in plant life by means of CD: Extensive work has gone into investigating the correlation between changes in the CD test pictures of saps and constellations of Moon, Mercury and Venus in relation to Sun (*A. Fyfe* 1967,1973,1978; *M. Engqvist* 1977). It would be a definite contribution to science if further research with CD would provide some *convincing* picture series, showing a clear correlation of changes in test series and planetary events. On the basis of our understanding of the method we would then be able to show that these influences work into the metabolism. In our view all so far presented, i.e. published, results are far from being conclusive. Firstly, because the standards of documentation are poor compared with any current scientific standards: No duplicate pickings and extracts, usually only one picture shown, representing each picking time and giving no indication about the experimental variations involved. We are aware, of course, of the problems of publishing perhaps 100 test pictures or more relating to one event, but at least they would have to be done and in some cases shown. Secondly, all CD studies on constellations with plant materials imply a larger number of pickings at different consecutive times. This asks on one hand for a high degree of uniformity of the source from which the material is sampled, and requires on the other hand that no, or no unknown rhythms and changes in the life processes occur over the observed period of time, which might result in metabolic changes relevant to the CD picture: both conditions being very difficult to find and demonstrate. The comparability of plant materials is, in the light of our knowledge of the basic processes in CD, a fundamental problem, apart from all the other experimental and technical difficulties which the method poses.

Acknowledgement:

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The January 1982 Science Conference

Hedley Gange

The Science Group conference was again held in the pleasant setting of Wynstones House, Brookthorpe, near Gloucester, from 2nd to 5th January 1982. There were three main lectures (by Nick Thomas, Alan Hall and June Woodger), nine shorter contributions, practical sessions in projective geometry led by Ron Jarman, numerous discussion periods and, for the first time at a Science Conference, eurythmy with Clio Osman and Judith Neilson, which proved very popular.

Nick Thomas discussed the possibility of developing a theoretical framework for the study of etheric forces, using *The Philosophy of Freedom* as a basis. Some basic concepts were first considered: what is a force? what is the difference between a mechanical and a living (etheric) force? Thinking is akin to light: it also contains a Will element which has some of the qualities of light ether. The feeling behind thinking is related to chemical ether, both having rhythmic qualities. The relationship of the ethers to both space and time were considered. Thinking is a combining or organising activity: we also observe organising agencies behind natural phenomena. This indicates a connection between these agencies, or forces, and thinking.

Alan Hall, speaking on the subject of 'Dowsing', described how he had come to find that he was in possession of water-divining faculties. He gave a remarkable demonstration, in the lecture room, of a variety of effects obtained by means of the usual bent wires held in the hand. Indications were given of whether a jar or similar vessel was open or closed, and different indications were given according to the direction from which the vessel was approached. Water pipes and objects made of certain materials were located.

Alan had evidently given more conscious thought than is usual in this field to what was actually taking place, although he had come to few definite conclusions. The phenomena raised many questions: were astral or etheric forces responsible for the movement of the wires? Were they moved under the direct influence of some force or field, or did the force cause the dowser himself to move them? Were the effects connected with the relationships of the different parts of man's being to the vertical and horizontal directions of space as described by Rudolf Steiner? Alan's experiments had led him to the conclusion that he, himself, was physically, but unconsciously, moving the wires.

The reactions of members of the audience varied considerably. There seemed to be a rather different 'feeling' than in normal scientific discussion. Some of those present felt it would be useful for one or two members of the Group to pursue this line of investigation, since extrasensory phenomena were being encountered increasingly in the modern world. Others approached this line of enquiry with caution, feeling that there may be a temptation for us to be led away from our primary tasks in science where so much was waiting to be done. (Rudolf Steiner's lecture of 7th January 1923, Dornach, *The Widening of Man's Perception*, has some relevance to the subject of this lecture. —Ed.)

June Woodger illustrated her lecture on *Etheric Formative Forces in the Realm of Plants* with coloured photographs of different species of plants in different environments: by the use of a technique of 'dissolving pictures' we were able to see a particular plant, first in summer sunshine, changing gradually to the snows of winter.

Plants were described as the manifestation of interweaving forces—planetary, astral, etheric, physical—blending with the daily and seasonal rhythmic processes of the earth. They provided an 'etheric landscape' and were also connected with man, inwardly, through their healing properties. Relationships between the four ethers, meteorological processes and the form, colour and life-cycles of plants were described. The etheric conditions (of light, warmth, etc.) were different at each season and there was a relationship between these conditions and the characteristics of, for example, spring- and summer-flowering plants.

Shorter Contributions:

How does the Etheric affect the Physical? Paul Breslau suggested that further attention should be paid to the processes occuring in the

human nervous system. What function do the chemical/electrical processes in sensory and motor nerves serve and are these processes truly directional? What is the nature of the associated etheric activity? Thinking is a supersensible activity; it is also real. It does not need a physical cause—although the activity is based, physically, in the brain. The position is a little different when mental pictures arise as the result of sensory stimulation. There is evidently scope for further investigation of the different forms of etheric activity involved in neural processes, and the associated etheric/physical relationships.

The Polarisation of Light. Nick Thomas gave a demonstration of a phenomenon involving polarised light, in which two sheets of polariod material (functioning like tourmalin crystals) were placed in the gate of a light projector. When the sheets were suitably orientated ('crossed'), most of the light was obscured. Insertion of a third polariod sheet between the first two resulted in a partial lightening of the field—a result which normally requires recourse to quantum mechanics to explain, with all the reductionist underpinning required by that theory. Rudolf Steiner's explanation is much simpler, namely, that 'form-building forces' (with directional properties) are present in the tourmalin, and these forces impart some of their directional qualities to the light. Observation of the effect of the substance on the light helps us to understand the nature of the forces underlying the solid state (*Warmth Course*, Spring Valley, N.Y., 1980, p.74).

The Botton Science Laboratory. William Steffen gave a short progress report on his work in the Laboratory, which is integrated as an organ in a larger working community with handicapped adults in the North Yorkshire Moors, and is run with the help of some 'villagers'. The aim of the work is to make a contribution to a science which recognises the fundamental universality of life: life manifesting the deep unity of the creative spirit, the forces of soul-life and the qualities of matter. The pursuit of science itself is seen as a living process. William Steffen is interested, particularly, in the methodology and scientific status of Capillary Dynamolysis: an article by him on this subject appears on page 3.

Plants and Planetary Colours. Howard Smith discussed the relationship between the 'planetary colours', as given by Rudolf Steiner, and the colours exhibited by plants. The question was posed, 'Is the theory of coloured pigments, known in chemistry and physics, in some respects a true (but sub-natural) reflection of the cosmic constitution of matter?' For example, what is the reality, in terms of formative forces rather than electrons, behind the 'higher states' of matter so central to this colour theory, and referred to as 'excited states'?

One example: Blue plant pigments (related to Saturn) and the green of leaves (related to the Sun) both rely on absorbing the warm end of the spectrum, which Steiner describes as bearing the warmth ether. The evolutionary significance of the two 'planets' and their relationship to the element of heat is a well known feature in Steiner's esoteric cosmology.

Similar relationships emerge when considering the other planetary colours in the plant kingdom. However, with coloured *minerals* the situation is more complicated, since Steiner does not give a simple one-to-one correspondence between planet and colour in this case.

Copper Chloride Crystallisations. George Corrin described how he had made use of the sensitive crystallisation technique, developed originally by E. Pfeiffer, in his work in the field of agriculture. This technique, as well as having practical applications, serves to make visible the working of the formative forces in living organisms. Characteristic crystallisation pictures were obtained when juices of, for example, a fruit or flower were added to a copper chloride solution. Substances from different parts of a plant gave different pictures: it was also possible to judge the degree of vitality of organic substances.

'Is the Heart a Pump?' When comparing Rudolf Steiner's statements on this question with orthodox views, it is desirable to consider first what current ideas on the circulation of the blood actually are, and this was the main purpose of **Sue Peat**'s contribution. The popular view is still that the heart acts as a pump, but after hearing Sue Peat describe the various factors involved and give some references to the literature of the subject and an impression of the clinical situation when, for example, emergency heart treatment has to be administered, the position did not seem quite so clear-cut. She referred to the nature of the blood-flow in different parts of the system—in the capillaries, the venous return and in the lungs. The circulation may be viewed from different angles—there is some interaction between the circulatory and respiratory systems. There seems to be a need to have resort at some point to the idea of a 'living agency' (in blood, muscle or nerve) in order to 'explain' the continuing activity. This is evidently a subject that merits further discussion.

The following three articles are based on short contributions by Matthias Klimm, John Soper and Hedley Gange.

A Phenomenological Approach to Light

Matthias Klimm

It is difficult to reconcile the usual view of light with insights arising out of anthroposophy (e.g. that light and thought are of the same substance). The usual view is that light is a physical or quasi-physical something (whether electromagnetic wave or not does not matter here) which originates from a light source, travels through space, is reflected by objects and, maybe, happens to enter a human eye. Manfred von Mackensen points out in his book for Waldorf teachers* that this view is based not on a purely phenomenological approach but on inference. It is impossible to observe light on its way from the light source to the object or from there to the eye; we simply infer that it is doing this. It is this inference which lies at the root of the problem. M. von Mackensen shows that observation of the phenomena leads to the following:

Most objects can be put in one of three groups:

1) Those that are bright by themselves (i.e. what is normally called light sources).

2) Those whose brightness depends upon their surroundings (i.e. most ordinary objects).

3) Those that are independently dark (really only a hole can be this).

The group to look at first is the second one. The question is: Under what conditions is such an object either bright or dark? (Or somewhere in-between.) It is found that each point on an object has a hemisphere above it in the same way that we have the hemisphere of the sky—or the hemisphere could be below or to the side. If there happens to be some bright object (whether independently bright or itself dependent in its brightness does not matter) in this hemisphere then that point will itself be bright. How bright depends on the brightness of the object in its hemisphere and on the angle it subtends there. This is the most basic phenomenon of light and can serve to explain the formation of shadows and much else. More detail can be found in von Mackensen's book.

Light understood in this way leads to a concept entirely different from the one we are used to:

"Then light is not a quasi-physical something, which spreads out somewhere, but light is the idea of the *interrelation* of the phenomena of brightness, an idea which has been formed solely through human observation and thinking." (Page 71)

(Perhaps von Mackensen should have said 'found' instead of 'formed' since light existed before man had the power of forming ideas.)

This concept of light allows one to understand that light is of the same substance as thought and also that space was created by the light as mentioned in R. Steiner's *Occult Science.*

* Manfred von Mackensen: *Klang, Helligkeit und Wärme*, Forschungsstelle des Bundes der Freien Waldorf Schulen, Kassel

The Transmutation of Elements

John Soper

In lecture 5 of the *Agricultural Course* Rudolf Steiner, while speaking of a loss of silicic acid from the whole cosmic environment, said among other things:- "Processes that are taking place around us all the time are as yet utterly unknown. . . For there is a hidden alchemy in the organic process. This hidden alchemy really transmutes the potash, for example, into nitrogen, provided only that the potash is working properly. Nay more, it even transforms the nitrogen, the limestone, the chalky nature, if it is working rightly. The fact is that, under the influence of hydrogen, limestone and potash are constantly being transmuted into something very like nitrogen and at length into actual nitrogen."

Around 1880 Herzeele showed in numerous experiments with germinating seeds that some elements increase in quantity while other decrease during the early stages of growth; his results were so contrary to accepted beliefs that they were disregarded.

Subsequently, from 1950 onwards, Dr. C.L. Kervran, Director of Industrial Medicine and Vocational Disease in Paris, and his followers have proved transmutations in many different biological fields.* His breakthrough came from his investigations into the metabolism of men working in intense heat on oilrigs in the Sahara.

Samples of their food and drink were analysed and the figures compared with analyses of all their excreta (sweat, urine and faeces) over a period of three months during the hottest weather. He found that, whereas there was a large intake of sodium, hardly any of this could be detected in the excreta; on the other hand a large excess of magnesium and potassium appeared. When the weather became cooler these effects vanished. The experiment was repeated the next year, and the analyses, conducted in a different laboratory, confirmed the originals. The inference of a transmutation of sodium into magnesium and potassium is inescapable. Further confirmation of this probability was later obtained by *in vitro* experiments. Two species of moulds and two different yeasts were cultured in media whose normal potassium salts were replaced by the corresponding sodium salts. Substantial amounts of potassium salts were found after incubating for three days, but there was no increase in potassium in controls done with the standard solutions. Kervran postulates that the potassium in salt deposits has been derived in this way; the older deposits (kainite) are far richer in potassium than those of more recent origin (silvinite).

Many other transmutations involving various elements have come to light, elucidating hitherto unexplained phenomena. They are too numerous to describe in detail in a short article, but here are a few examples. Saltpetre (KNO_3) can be regularly scraped off a limestone wall containing originally little if any potassium, provided that the right micro-organism is present. The change goes the other way in the case of hens: if they are starved of calcium grit, they soon lay soft-shelled eggs, but the eggs return to normal two days after feeding potassium-rich mica, which they gobble up ravenously. Recalcification of broken bones in chicks takes place far more rapidly and effectively when silica-rich equisetum tea is fed instead of a calcium supplement to the diet. The limestone of Notre Dame Cathedral was found to have developed a coating of silica and a film of carbon which seem to act as a protection, so it was decided not to proceed with cleaning. On the other hand granite statues and buildings get coated with $CaCO_3$ or $CaSO_4$ which definitely are not derived from rain. Old Cambodian temples built with iron-rich stone become coated with MnO_2; this reversible transmutation is also found in young plants. Moulting lobsters and crabs get the calcium for their new shells from the magnesium in the sea water (proved by experiments in tanks). Certain seaweeds growing on stanniferous granites convert the tin into iodine. My final example could provide a research basis for those concerned with the disposal of radioactive wastes: the radioactive isotope Hg_2O_3 decays at the expected rate in sterile conditions, but in the presence of various bacteria decay proceeds very rapidly. The medical team doing the investigation assumed that the mercury had volatilised!

In terms of present atomic concepts transmutation must involve changes in the make-up of the nuclei. Kervran, using atomic weights as a basis, shows how all his cases can be 'explained' by the absorption or expulsion of a comparatively simple nucleus. For example:

Na (23) + H (1) ⟩ Mg (24)
Na (23) + O (16) ⟩ K (39)
Si (28) + C (12) ⟩ Ca (40)
Ca (40) - H (1) ⟩ K (39)

The series Si ⟨⟩ N_2 and CO ⟨⟩ N_2 involves merely a redistribution of protons.

Kervran postulates vast transmutations not necessarily involving living organisms during past geological ages and theorises that all the heavier chemical elements could have been built up from a few simple ones. One wonders whether the mineral/plant and the plant/animal described by Rudolf Steiner as arising from an old living albuminous atmosphere are responsible for many of Kervran's phenomena, and plant/animal is not a bad description of bacteria. Is it possible that the bacteria which we find in our environment to-day are the descendants of the old plant/animal and mineral/plant, still retaining some of their amorphous but very vital qualities? Or again, are these minute organisms really individualised? or are they better seen as processes brought about by elemental beings?

* Kervran, C.L. *Biological Transmutations*, The Soil Association

The Etheric Formative Forces Today

Hedley Gange

After half a century of investigations, where does the study of etheric forces stand to-day? Anyone who has noted the difference between sitting in a darkened room and walking out into the garden on a sunny day will have some idea of the meaning of 'the etheric realm', and the term occurs frequently in anthroposophical conversation. But, as scientists, how precise is our knowledge, how far

can it be said that there *is* a systematic study of the etheric realm, to what extent are we able to observe, handle and control these forces? Perhaps it is now a suitable time to survey the whole field and attempt to integrate the results of different workers into a cohesive whole? I would like to refer to a few aspects of this process.

The first, brilliant exposition was by G. Wachsmuth in his book *Etheric Formative Forces in Cosmos, Earth and Man.* This was first published, in German, in 1923, and was later translated into several other languages. A student picking up the book today would do well to remember that the treatise was, necessarily, tentative in many respects. Much seems to have been presented on the authority of Rudolf Steiner: this is still of interest but the question of supporting evidence is now, of course, vital. The formative qualities of the etheric forces are described, and various examples are given of the characteristic forms produced by the activity of each of the four ethers, e.g., half-moon forms produced by chemical ether. These descriptions have been widely quoted.

In a later work, by E. Lehrs, *Man or Matter,* published in 1951 (Faber), rather less emphasis is placed on the formative properties of the etheric forces, and the four characteristic forms are not mentioned. The phenomena of life are attributed to the interactions of etheric and 'gravitational' forces, but this activity is determined and controlled by other (astral) forces. According to this view, chemical ether, for example, has the power of reaching deep into matter to imbue it with all manner of qualities but the controlling impulse must come from outside the etheric realm. Another worker, Theodor Schwenk, who is concerned particularly with the realms of water and air, writes; "Out of the world of the celestial laws of the stars, ... the spirit descends, ... to be revealed in the ordering of number and substance in organic form. The laws of the stars descend and, through the mediating elements of air and water, impress themselves upon the earth." (*Sensitive Chaos,* Rudolf Steiner Press, 1965, p.125). The four ethers are the mediators through which the spirit is able to become physically manifest.

In *The Nature of Substance* by R. Hauschka (Vincent Stuart, 1966), the differences between substances are not discussed in terms of chemical, or other, ethers,—"As the great spiral of creative evolution rolls in from the cosmos towards the earth, passing through the various planetary spheres as time goes on, it transmits the formative impulses radiating from the zodiacal constellations to the earth." (p.225). The book does not deal with form in a morphological sense, but the following statement is included; "The half-moon form is the basic shape created by the ordering force of chemical activity present in the fluid element." (p.97). This statement is not elaborated.

Life ether, as generally described, has the function of making possible the 'living chemistry' within a plant, or other organism, building on the conditions provided by the chemical ether. Both these ethers are described by Wachsmuth as having some 'gravitational' (centripetal) characteristics in contrast to the light and warmth ethers which are expansive. However, Lehrs speaks of the fundamental polarity of Gravity and Levity and of the four differentiations of Levity (or Ether). It is, perhaps, possible to consider say, chemical ether as being purely ethereal, i.e. having no gravitational properties but as having developed the power of working in a gravitational environment, in the world of matter.

Plants are described in, for example, *Fundamentals of Therapy* by Rudolf Steiner, as having an 'ether body'. What is the relationship between this and the four ethers working within it? The ether body is peculiar to a particular organism and seems to exert an organising or controlling influence. It incorporates, therefore, both etheric and *other* forces—i.e. the etheric forces do not, themselves, have the capacity to form 'a body'.

G. Adams and O. Whicher have developed the concept of 'ethereal space', both mathematically and artistically. This is the 'growing space' of the part of the plant above the ground, especially of those points where the growth is most intense. This activity takes place in conditions of light and air. It is, perhaps, useful to remember, when dealing with the etheric realm as a whole, that ethereal space is, in fact, the space of light ether.

Agnes Fyfe drew attention, in her letter in *Science Forum* No.3, p.30, to references to formative activity in Chapter 3 of Rudolf Steiner's *Agricultural Course.* Here we read of "creative and formative cosmic pictures ... out of which all that is formed in Nature must ultimately proceed". These spiritual influences become manifest in specific substances—carbon, oxygen, etc.—all of which require the ethereal element as their basis.

Finally, there are the various experimental techniques, such as capillary dynamolysis, which are sometimes said to make visible the etheric forces. The main effort up to now has been directed towards perfecting the techniques and establishing correlations between, for example, certain features of the pictures obtained by the use of plant saps and planetary movements. An examination of the questions of (1) the relationship between the processes taking place on the filter paper and living activity within the plant and (2) the nature of the forces giving rise to the forms appearing in the pictures has been initiated by William Steffen (See article on page 3).

News and Comment

MARGARET WILKINSON RESEARCH FUND
Current Projects

In 1981/82 three research grants were awarded by the Margaret Wilkinson Research Fund (for details of the Fund, see *Science Forum* 3, p.14).

William Steffen of Botton Science Laboratory received a grant to enable him to continue with his researches into capillary dynamolysis. A report of this work appears on page 3 of this issue.

Graham Calderwood has been researching leaf and bud shapes using projective geometry. An extensive report on this will appear in the next issue.

Lawrence Edwards was delayed in taking up his research grant (see note in issue No.3, op. cit.), but has eventually done so.

Howard Smith

Lawrence Edwards writes:

I have three research projects on hand at the moment. The first concerns the λ-values of the buds (see chapter 5 of my book *The Field of Form*). When I started this work many years ago I supposed that each species would have its own λ-value, which would be constant for, and characteristic of, that species; I was much concerned to find just what these numbers would be, for a wide range of species. Later it became clear that a bud of any given species would go through a range of λ-values during the course of its development and opening; and there arose what I now call an 'opening chart', a graph showing the variation in λ as the bud opens; and some typical specimens of these are shown in chapter 7 of that book. Although there were found to be general characteristics which were common to all (or nearly all) opening charts, it soon became obvious that each species differs in many details from others in the way of its opening; and again I have supposed that the details of an opening chart, once they have been measured and charted, would be constant and characteristic for that species. And I still believe that, in the main, this is true. Nevertheless recently it has become clear that there is more to it than just this. Species have been found which grow, in these subtle respects, differently from one year to another. Some influence or influences unknown are working upon them to modify the manner of their growing. For instance the little Ladies' Smock was blossoming here in Strontian this year with an opening chart which was very similar in its general form to that which it showed two years ago, but with all-round λ-values considerably higher than it showed then; while the Primrose this year was growing with markedly lower values than two years ago. I am therefore proposing to choose some 15 to 20 species which grow wild and profusely round here, and monitor their opening charts year after year, to try to find what periodic, or quasi-periodic fluctuations they may show. Obviously this is a long-term project, and dramatic developments cannot be expected in less than quite a number of years.

But there is a shorter term, and very important, aspect of this. The deciduous trees, oak, elm, beech, etc., develop their next year's leaf buds during the latter part of this summer. By mid-September these buds are already full-grown on the tree, and they wait there like this, to superficial appearance constant in form, until they open some seven months later. Just this year some evidence has come to hand to suggest that these buds are in fact not so constant in their form all through the winter as would seem. I am therefore developing a technique which will photograph an individual bud, on the tree, over the months, in such a way that one can guarantee, as far as it is at all possible, that it will be seen from *exactly* the same angle each time. I am therefore proposing to follow the history of a few selected buds, right through the winter, to find whether there are any other influences working upon them apart from the ordinary terrestrial ones of temperature, humidity, intensity of light, barometric pressure, etc.

Secondly I want to continue with the work on the heart which I illustrated in chapter 8 of my book, particularly with respect to the little seven-fold rhythm within the single heartbeat which I described there. But work on this will depend on my being able to get some good clear angiograms for measurement.

Thirdly I want to make a much more thorough exploration of the possible field of embryo forms than I have hitherto been able to do. Working 'longhand', this task would take far more time than I would possibly be able to give to it; but now that the Margaret Wilkinson Fund have enabled me to buy a computer capable of high-resolution graphics, such an exploration comes within the field of possibilities. The machine is already producing excellent pictures, and I am hoping to do much with it.

The Prime Number Domain

echo of what is individual in the world

Ron Jarman

No-one deserves the right to be called a mathematician—whether at humble or sublime level—who has not been delighted with the life of number as it reveals itself in the field of integers. At a humble level one meets children of eight or nine years of age thrilled by the patterns of relationships in the multiplication tables. Later comes the feeling of awe, of deep wonder that whereas innumerable formulae crystallise the sparkling relationships among composite numbers, the sequence of prime numbers utterly refuses to submit to formulation in this manner.

An example of the former is the joy of experiencing that 91^2-89^2 is simply 2 x 180, thus sweeping away tedious multiplications. The totality of all similar experiences is expressed in the formula $x^2-y^2 = (x-y)(x+y)$, much in the same way as immediately after death we find expressed in the etheric body's life tableau (panorama) the essence of everything we experienced during the life on earth which we have just concluded.

An example of the latter is the remarkable prime number formula $2n^2+29$, n integral. Thus for n = 0, 1, 2, 3, 4, —we have the primes 29, 31, 37, 47, 61, —and the successive differences are 2, 6, 10, 14, —whose differences in turn are each 4. But, of course, the formula fails when n=29. So a set of 29 primes has submitted to a formula, but then this special sequence of primes asserts its freedom once again. "Enough!", it cries.

The Greeks loved to describe integers according to whether the sum of their integral divisors (including unity but not the original integer itself) was greater than, equal to or less than the original integer.

Thus 12 was excessive (1+2+3+4+6>12)
6 was perfect (1+2+3=6)
10 was deficient (1+2+5<10)

But this is a beautiful way of exhibiting the threefold nature of the *composite* number domain. Prime numbers really make a fourth category. To say that 7 is deficient (1<7) hardly does justice to the quality of being prime.

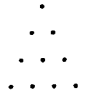
Just as the human being contains something essentially different from the mineral, plant and animal; just as the ego is a quite different kind of entity from the physical, etheric and astral bodies, so is the prime number compared to the three kinds of composite number. Incidentally, one will also be rewarded by meditating upon the *qualitative* isomorphism between the three bodies and the three categories of composite numbers—in the same order as given above.

Not only does the complete sequence of prime numbers show an individual (non-formulable) quality, but so does each individual prime number. The world of fiveness is so different from the worlds of threeness and twoness. (Here one is reminded of the difference between dicotyledons and monocotyledons, emphasised by the very numbers just quoted). Sevenness is the only possible number to express the planetary domain. The secret of 7 (3+1+3) is the secret of evolution in time. It is not a space number. 7 is the lowest number of parts into which a circle cannot be divided exactly using ruler and compasses. To contemplate numbers (especially prime numbers) as beings—at first examining them purely mathematically—can lead one into the number (or chemical) ether and thence to what Goethe indicated as the 'realm of the mothers'. But one must eschew the merely mystical; everything has to be pursued in the clearest mathematical consciousness.

Three examples may be cited—two from the New Testament and an earlier (archetypal) one from Ancient Greece.

At the end of St. John's Gospel there is the story of the 153 fishes. It was the discovery of St. Thomas Aquinas which explained this extraordinary catch of fish—for why did the bible not simply say "about a hundred and fifty fish"? As was the custom in those days the creative power of any number was expressed by uttering the triangular number derived therefrom. The most important example is the well known reply of Pythagoras to a novice—"What you take to be 4 is in reality (i.e. as power) the number 10"

Thus 1+2+3+4=10



Similarly 1+2+3+ ..... +16+17=153

153 is the creative result of the force of 17.
As a formula the triangular number of n is n(n+1)/2. Aquinas pointed out that 17 is in fact 10+7, the union of the earthly (10 : we have ten fingers and ten toes and so have a denary counting system) and the heavenly (7 : the planetary worlds). Christ's deed was to bring the heavenly down into the very earthly. So is manifested this power in the catch of 153 fishes. The Ravenna Mosaic (San Apollinare Nuovo) composed about 500 A.D. on the "Calling of St. Peter and St. Andrew" shows this very net in the form of a triangle.

The deepest secrets of the human being are to be found through meditating on the 4 to 10 triangle of Pythagoras. The actual triangle, carved upon a tablet and given to novices as a subject for meditation in the Pythagorean Mystery Centre at Croton, is built upon the Hebrew word for Jehovah (or Jahweh, or Jayway). This is written backwards in the bottom row. In the ancient languages one wrote from right to left.

Interpreting this in the simplest way it tells one that whereas we normally speak of four kingdoms of nature, there are actually ten. For the plant has an etheric body as well as a physical body. The animal has in addition an astral body, and the human being has a fourth principle, the ego. Thus we obtain 1+2+3+4=10 : earthly phenomena altogether.

The second example comes from contemplation of another triangular number noticed by the writer when reading the Acts of the Apostles. The dramatic story of the shipwreck ends by telling how all 276 souls were saved—following Paul's converse with the Angel of God. 276 is the triangular number of the prime 23. What is special about 23? The ancient Kabala (literal meaning: the power of the two and twenty) had 22 letters, in fact 12 (zodiac) + 7 (planets) + 3 (the mothers). But to these three groups the Christ brought the fourth—the ego which is unique. So 23=12+7+3+1. This new power, that of Christ united with and transforming the great wisdom of the past, reveals itself in the saving of all 276 souls.

Such secrets can only be penetrated by first immersing oneself wholly within the purely mathematical and second carrying this active consciousness into the spiritual—transforming it into Inspiration. Yet one has to delve as deeply as possible into the life of number to do so. What mathematically is special about the prime number 23?

In the theory of numbers there is that wonderfully stimulating branch dealing with fundamental functions, congruences, residues, etc. Every prime number has its 'primitive roots'. A good book on this subject is that by I.M. Vinogradov (Academy of Sciences, U.S.S.R.) *Introduction to the Theory of Numbers.*

For example, 3 is a primitive root of 7, but 2 is not. Thus:

$3^1 = 3$	but $2^1 = 2$
$3^2 = 2 \pmod 7$	$2^2 = 4$
$3^3 = 6 \pmod 7$	$2^3 = 1 \pmod 7$
$3^4 = 4 \pmod 7$	$2^4 = 2 \pmod 7$
$3^5 = 5 \pmod 7$	$2^5 = 4 \pmod 7$
$3^6 = 1 \pmod 7$	$2^6 = 1 \pmod 7$

The powers of 3 give *all* the mod 7 residues, but the powers of 2 do not. Now 23 is the smallest prime number for which 5 is the lowest primitive root (all smaller primes like 11 or 17 have 2 or 3 as their lowest primitive roots). That is a purely mathematical statement. But having understood it one will notice that one has crossed a threshold similar to the one mentioned earlier—going from monocotyledon to dicotyledon.

23 is also a threshold in the theory of Kummer primes. Question: Uranium has 92 as its atomic number. 92=4x23. Has this also got a threshold significance?

It has long been realised that the smaller a number is, the more important it is. A child may be forgiven for supposing that a thousand, thousand, million, million is very important. But behind the scenes, so to speak, we are really concerned with 2 and 5 there. The mysteries of the smaller primes are of the greatest moment. What is elevenness? "What has 11 to do with the secret of the Sun?" would be a consequent question (an important one, as this was used in the Greek modes in music).

To find out the unique nature of each separate prime number is one of the hardest tasks—and now we are speaking purely mathematically. Attempts to do so by means of comparisons between prime numbers eventually evaporate in the end—it is as if these very numbers were saying "You must follow us out beyond the purely mathematical, penetrate the spiritual world of

continued on page 27

Flowform Rhythms

N.C. Thomas

Introduction

John Wilkes invented the flowform method more than ten years ago, and since then considerable effort has been expended in making such forms for both artistic and practical purposes (e.g. 'fountains' and sewage treatments). A persistent question has been: does the rhythmic movement induced in the water by the flowform improve its quality or its ability to support life?

Extravagent claims are not being made by the Flow Research Group although extravagent assertions by third parties do sometimes appear in print! These should be treated with caution.

A first step in the study of rhythms induced by a flowform is to record the actual movement over a period, and then to discover the inherent frequencies making up that rhythm by means of harmonic analysis. Parallel experiments to investigate the effect of rhythms on living organisms would be capable of considerable extension if the effect of different kinds of rhythm could be studied. Some rhythms might have greater effect that others, while some might be beneficial and others harmful.

What is meant by 'rhythm'? This should be distinguished from mere frequency. A rhythmic phenomenon exhibits waxing and waning; indeed it is a combination of long and short period vibrations. Fourier showed that any periodic waveform may be analysed into component sinusoidal waves of definite amplitude and phase. The 'fundamental' (i.e. dominant) frequency is modified by harmonics of higher frequency, those harmonics having frequencies that are integral multiples of the fundamental. The overtones of a musical note are an example of such harmonics. There may also be longer-period component frequencies. A particular rhythm may be characterised by the component frequencies that Fourier analysis reveals.

This report concerns the first investigation, made by the author, into the nature of flowform rhythms. At the outset it was not known whether all flowforms have similar rhythms, or indeed any rhythm at all, when operating in isolation. The work falls into two natural stages: firstly to determine the basic rhythm of each type of flowform when operating in isolation, and secondly to see the effect when a number of flowforms operate in cascade. This report largely concerns the first stage, with only one preliminary result for the second.

Method

The method adopted was to measure the depth of the water, at a suitable position in the flowform, recording the measurements at regular intervals. The results characterise the rhythmic change in depth over the measurement period. These 'time domain' depth measurements are then transformed mathematically into a 'frequency domain' plot of the rhythm, i.e. the mathematical transform, known as a fourier transform, determines the component frequencies from the series of depth measurements.

Three major requirements are:

1) The measuring device must be linear to avoid intermodulation and cross-modulation products.
2) The depth measurements must be equally spaced in time.
3) The sampling interval (i.e. time between depth measurements) must be carefully chosen to suit the range of frequencies of interest.

The investigation required firstly the development of a suitable depth measuring probe giving an electrical voltage analogue of depth. Secondly the development and construction of an electrical interface to enable the resulting measurements to be input to a computer. Thirdly the development of suitable computer programmes to store, analyse and plot the results.

Depth Probe

The depth probe developed was based on electrochemical principles, and more sophistication was required than initially envisaged to obtain an acceptable dynamic range together with reasonable linearity. Non-linearity results in the production of both intermodulation and cross-modulation products in the final spectrum, which have to be discounted. The development has reached the point where linearity is good enough to permit easy recognition of such products in most cases, but not good enough to eliminate them. The initial application has thus been carried out in this context.

Interface

The interface requirements are:

a) To provide a sampling interval clock variable between 100Hz and 0.01Hz

b) To provide a filter to remove all frequency components above the Nyquist frequency (to prevent aliasing).
c) To provide an analogue-to-digital conversion of the voltage analogue of water depth suitable for input to the computer.
d) To provide a front end interface circuit for the probe, comprising an operational amplifier current-neutralization circuit together with a DC amplifier to permit adjustment of both zero reference and gain for dynamic range optimization.

An interface using integrated circuits was designed and built to meet the above specification.

Programmes

The programmes are written for a Commodore CBM computer. The number of depth measurements taken is 512 on any one run. They are recorded on cassette after completion of the run for use by the analysis and printing programmes. The range of sampling intervals allows for runs lasting from a few seconds to eight hours to permit different bandwidths to be studied. The analysis and printing programmes calculate the frequency interval from the time domain data, the sampling interval being accurately determined by the computer at the end of the run. This is printed together with informal information at the head of the actual plot. The plot is produced in the form of a bar-chart with normalised amplitude, showing the relative energy in each frequency interval.

Procedure

The experimental procedure consists of the following steps:
a) Mount the flowform to be studied, ensure correct operation, and determine the period of oscillation.
b) Mount the probe, inserted at a suitable point
c) Start the computer programme and adjust the sampling interval (initially displayed on the V.D.U. for this purpose) to at most half the flowform period of oscillation.
d) Adjust the zero and maximum digitised readings to optimise the dynamic range.
e) Start the actual run and record the results on completion. They are stored cyclically so that the run may be stopped at any time after the computer indicates that 512 or more samples have been stored. This permits an over-run should there be any reason to discount the beginning of the run. The computer provides an estimate of completion time for planning purposes.

Results

So far 56 runs have been completed on 19 different designs of flowform. The aim has been to determine whether the rhythms are simple frequencies or are compounded of several components, and to what extent there is any diversity or commonality between forms. Should there be diversity then the choice of flowform for a given scientific application can be studied to see the effect of the type of rhythm on the process under study (e.g. on the support of living organisms).

It turns out that there is diversity, some flowforms showing remarkably simple rhythms (e.g. figure 1, see notes on interpretation of the figures at the end) and others more complex ones (figure 2). A table of flowforms and their rhythmic characteristics thus determined is shown in figure 7. The rhythm may be considered non-simple in two ways:
a): There may be frequency components distinct from the fundamental
or b): The fundamental (corresponding to the obviously visible pulsing of the flowform) may be 'spread'.

The first kind indicates distinct oscillations in the flowform while the second shows that the fundamental itself is varying rhythmically in the course of the run. Both kinds were found, usually simultaneously. The second frequency was usually of lesser amplitude and frequency, but cases were found where it was of similar or even greater amplitude (figure 3). Also, some flowforms exhibited a high frequency component typically around 12Hz, which may be attributed to surface waves in those forms in which the water is relatively deep.

The slower secondary frequencies appear to be related to the half of the flowform in which the probe is inserted since they were distinct in the case of asymmetrical flowforms.

In one or two cases the probe was inserted in the centre of the form, and strong secondary frequencies were then apparent (figure 4). The reason for this needs further investigation.

A single test was done on a cascade of 12 forms, and the isolated flowform characteristic (figure 5) compared with that of the ninth form of the cascade (figure 6). The considerable spread demonstrates the fact that longer term rhythms are active, and are affecting the fundamental. The non-linearity of the probe presents difficulty in this case, as it is less easy to eliminate cross- and inter-modulation products.

Conclusion

The following conclusions may be drawn
a) There is more diversity than commonality between flowforms.

b) Rhythms are often complex even in isolated flowforms, showing both variation of the fundamental frequency and distinct frequency components, indicating that rhythm is a controllable factor at the design stage.
c) Cascades induce more complex rhythms, as would be expected.
d) Some flowforms possess very strong secondary frequencies.

Notes on Interpretation of Figures

In each case the figure has as its ordinate the power amplitude of the frequency components, and as abscissa the frequency. The left hand end is zero Hz (cycles per second) and the right hand end is 256 multiplied by the frequency interval printed at the top (e.g. 0.46Hz for fig.1). Intermediate frequencies are calculated proportionately, and the markers every 14 intervals aid in this.

For example, the obvious pulsing of the flowform in the case of fig. 1 was measured with a stopwatch and found to be 2.35 seconds. The highest bar on the graph is at a frequency of 243 x .00179490248=0.436Hz, corresponding to a period of 2.29 secs. Other frequency components are found similarly.

In each case the Nyquist frequency filter used to prevent aliasing was set to twice the highest frequency on the graph (e.g. 0.92 Hz for fig.1)

Acknowledgement

Financial assistance received from the Cultura Foundation and the Margaret Wilkinson Fund is gratefully acknowledged.

Fig.7

Flowform	Pos	F0	F1	F2	F0/F1	Ampl	Diameter
Malmer	3	.36	.023		15.61	.73	94
Malmer	1	.381	.252		1.51	7.3	94
Malmer	2	.382	.068	11.66	5.62		
Brofjord 1	4	.775	.113	2.314	6.86	7.14	43.8
Brofjord 2	2	.789					
Acrylic	4	.429	.135	14.653	3.18	1.05	77
Gogut RH	4	.478	.266	12.464	1.8	2.9	67
Gogut LH	2	.476	.289	7.402	2.55	3.85	67
Akalla Large	1	.221	.046	11.985	4.8	6.67	158
Akalla L	5	.22	.055		4.00	.78	158
Akalla Medium	4	.859					43
Akalla Medium	4	.558	.311	7.782	1.79	4.76	67
Godager	4	.903	.270	3.84	3.34	3.57	29
Olympia 7 RH	4	.435	.124	12.735	3.51	4.55	92
Olympia 7 LH	6	.436		9.266			92
Olympia 6 RH	7	.325		12.218			106
Olympia 6 LH	8	.351	.033	1.144	10.64	2.94	106
Jarna Single	4	.668	.249	13.54	2.68	6.45	47.5
repeat	4	.672	.304		2.21	6.25	47.5
Jarna Casc 9th	4	.686	.0156		44.00	1.41	47.5
repeat	4	.695	.0224		31.03	.41	47.5
Olympia 2	4	.218	.045	7.262	4.86	5.41	146
Olympia 3	4	.363	.099	13.277	3.67	2.67	93
Olympia 4	1	.361	.097	6.974	3.73	1	87
Flat form	4	1.028	.453	8.48	2.27	1.85	24.3
Cylindrical 1	4	.84	.0196	8.24	42.84	.78	37.5
Cylindrical 2	4	.569	.203	6.385	2.8	2.18	72

F0 = Fundamental frequency (observable pulsing)
F1 = Slower secondary frequency
F2 = Higher secondary frequency
Ampl = Ratio of amplitudes F0/F1
Diameter = Total span orthogonal to main flow direction.

Fig.1 : Olympia 7 left. Position 6

Sampling interval: 1.08815104 sec. Markers every 14 intervals. Normalised amplitude.
Frequency interval: 0.00179490248 (70 int: 0.0125 140 int: 0.25 210 int: 0.38)

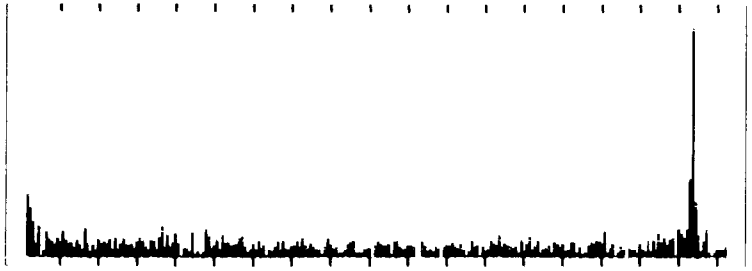


Fig.2 : Olympia 3. Position 4

Sampling interval: 1.22128906 sec. Markers every 14 intervals. Normalised amplitude.
Frequency interval: 0.00159923237 (70 int: 0.11 140 int: 0.22 210 int: 0.34)

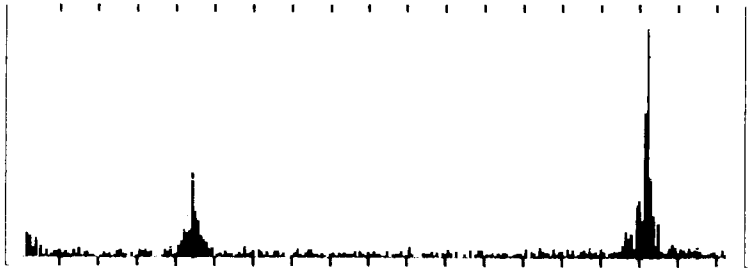


Fig.3 : Acrylic. Position 4

Sampling interval: 1.0117513 sec. Markers every 14 intervals. Normalised amplitude.
Frequency interval: 0.00193043982 (70 int: 0.14 140 int: 0.27 210 int: 0.42)

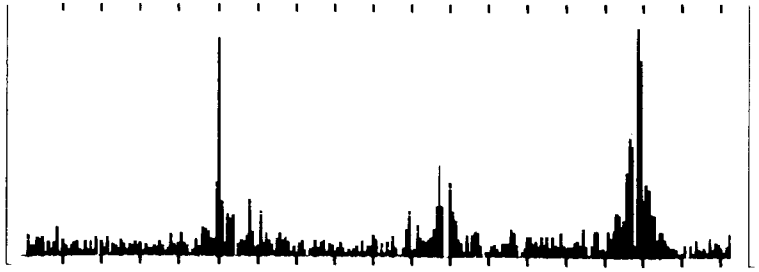


Fig.4 : Malmoe. Position 3

Sampling interval: 1.35546875 sec. Markers every 14 intervals. Normalised amplitude.
Frequency interval: 0.00144092219 (70 int: 0.10 140 int: 0.20 210 int: 0.30)

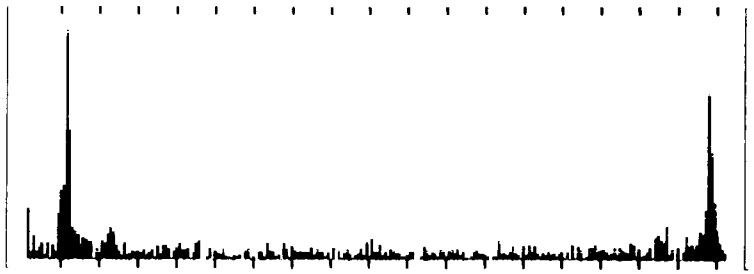


Fig.5 : Jarna Single. Position 4

Sampling interval: 0.634472656 sec. Markers every 14 intervals. Normalised amplitude.
Frequency interval: 0.00307834385 (70 int: 0.22 140 int: 0.43 210 int: 0.65)

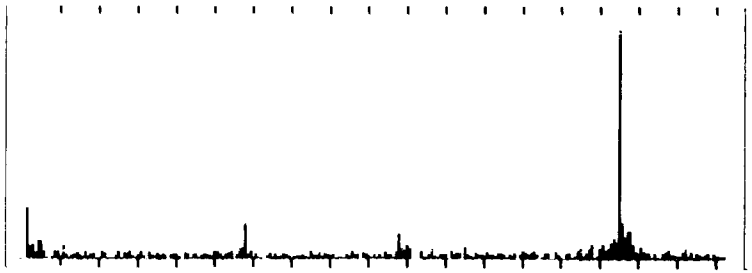
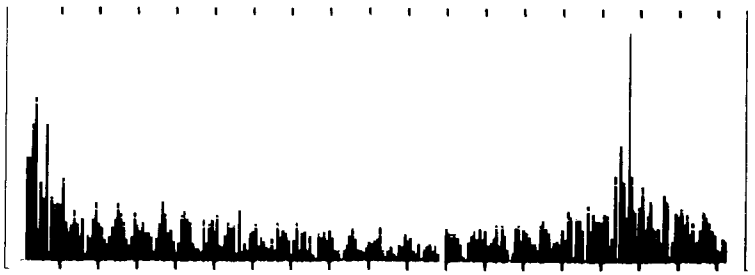


Fig.6 : Jarna Cascade.

Sampling interval: 0.625976563 sec. Markers every 14 intervals. Normalised amplitude.
Frequency interval: 0.0031201248 (70 int: 0.22 140 int: 0.44 210 int: 0.66)



The Only True Realities

Charles Davy

Imagine you are standing in an English garden on a fine day in June. Here all around you, in flowers, bees and butterflies, is sufficient evidence, it seems to me, that the strict Darwinian account of evolution falls far short of the truth. Some essential factors are missing.

More than this; there are marks of wisdom in the wonderfully intricate functioning of living creatures, and of artistry in their design.

Look at the tiny, bright tropical fish in an aquarium: they are jeweller's work. Or, at the other extreme, think of the strange creatures living in perpetual darkness far down in the deep oceans—whose handiwork are they?

All living creatures, I would say, derive from the thoughts of the Hierarchies and their servants. The tropical fish are the embodied thoughts of an artificer who takes delight in them.

Eternity is in love with the productions of time, so Blake believed. Then what of the creatures in the ocean depths? They are the embodiment of strange, darker thoughts; and so perhaps are all manner of noxious creatures, poisonous or inimical to man; for in the ranks of the Hierarchies all is not harmony; there are powerful aberrant Beings who are permitted to oppose the Divine Will.

We are told by Rudolf Steiner that long before man appeared on earth, he was thought by the Hierarchies, but not yet as an individual. Before that could come about, the human image had to be clarified, its excesses cast off. These excesses gave rise to animal forms, archetypal forms; and before man came down to earth, the animals came down—but not in the form we know today, for these are the outcome of very long epochs of evolution, in which natural selection has played a part; but when a new species appeared, it was, I would surmise, a new thought.

We may hope that we have here a picture of evolution that is nearer to the truth than pure Darwinism can be, but I think we should not expect to encompass the whole truth or the full why and wherefore of it. Think of the amazing profusion and variety of plant and animal species or of the vast realm of micro-organisms. It is all on a scale that baffles comprehension. And through it all runs an impulse that is seemingly reckless and ruthless: prolific Nature cares for the species, not for the individual organism.

If we now turn to the astronomical universe, what does it say? Until recently it would have seemed to speak of majestic order. Thus Meredith could write of *Lucifer in Starlight*:

> He reached a middle height and at the stars,
> Which are the brain of heaven, he looked, and sank.
> Around the ancient track marched rank on rank
> The army of unalterable law.

But now the astronomers have found that scattered among the myriad stars there are strange objects and unexplained phenomena. It appears that the rule of law no longer has a Newtonian simplicity: there may be laws or aberrations not yet understood. At the same time new observational resources have seemed to show a universe vaster than could have been imagined a century ago, with countless galaxies, each embracing billions of stars, ranged out over distances measured in millions of light years and all apparently rushing away from us. Once more it is all on a scale that defeats understanding.

But before we succumb to the paralysing impact of figures, we should remember that all natural phenomena, far and near, are appearances, *maya*. They are not illusions in the sense of subjective hallucinations, neither are they themselves deceptive: they become so only if they are taken for final reality.

In the course of a lecture given in Cologne on 18th December 1913, Rudolf Steiner said: "It is well never to lose sight of the fact that fundamentally there is nothing in the universe but *consciousness*. Everything outside the consciousness of Beings—of whatever order—belongs to the realm of *maya*, the great illusion ..... The only true realities in the universe are therefore Beings in different states of consciousness. It is because we who live in the state of human consciousness, and with this consciousness have no complete survey of the realities, that what is not reality appears to us as though it were."

It could be useful to distinguish between first and second order appearances. First order appearances are those we perceive directly through our senses; second order appearances are those perceived only with the aid of instruments—microscopes, telescopes, spectroscopes, etc. There is a temptation to suppose that second order appearances are in some way more real or more basic than those directly manifest to our senses, but this is not so. Second order appearances arise from the use of certain instruments and experimental procedures; they exist only in their instrumental context. Their useful-

ness is that they can serve as tools for gaining increased knowledge about the structure of the material world; they furnish physicists and cosmologists with occasions for framing hypothetical models of structures and processes.

If we now try to look at modern science from this viewpoint, how should we describe its activities? One might say that scientists are engaged in laying out the ground floor and basement of a building which will rise by stages in the future. At ground level the first order appearances look like solid realities; those of the second order can be interpreted in terms of one or another theory. The next level above, the etheric, is perceptible only by a heightened consciousness. For this consciousness (one gathers) the appearance of the living organism is seen to be not static but in continual flowing movement on the stream of time. Thus Rudolf Steiner speaks of the etheric body as a time-body, and also as the bearer of memories.

There are signs of an awakening need to move up somehow from the ground floor, in connection particularly with patterns of growth, during the embryonic period and later. It is not easy to explain in terms of genetics and chemical affinities how fragments of living tissue are induced to assume the right shape and to be in the right place for orderly growth at the right time. Hence renewed attention is being given to the idea of 'morphogenetic fields', which could have some relation to the etheric formative forces often spoken of by Rudolf steiner. But it is deceptively easy to pursue such ideas in a framework of ordinary concepts and so to regard morphogenetic fields as similar to magnetic fields at the physical level. The physical body, visible to ordinary sight, is an appearance, *maya*, but equally so is the etheric body, visible only to heightened perception (clairvoyance). For the reality behind the etheric body we must think of the Beings of the Second Hierarchy. In Steiner's words, the human etheric body "is a working and flowing and weaving together of the Exusiai, Dynamis and Kyriotetes, who individualise their streaming, flowing, resounding, speaking activity, and form the human etheric body."*

Perhaps the best approach to the etheric for many people today is through projective geometry, recommended by Rudolf Steiner and developed by George Adams, together with Olive Whicher. We have here to think of the etheric formative forces as polar opposites of the point-centred forces encountered in physical science, for instead of radiating outwards from a central point, they radiate inwards as enveloping planes from the infinite periphery towards a central point—e.g. the growing point of a plant. George Adams brought this way of thinking into relation also with the potentising of homoeopathic remedies, a procedure well attested but lacking a rationale.

However, while science may be moving towards the etheric, it is also exploring the basement realm of sub-nature, whence electricity derives and where the terrible potentialities of nuclear fission reside. Not only human moral issues are of concern here, but something else not generally recognised: the fact that Nature is not morally indifferent and cannot be so, for her realms are the scene of conflicts between those spiritual powers who serve the Divine Will and those who are permitted to oppose it under the names of Lucifer and Ahriman. The realm of sub-nature is one in which Ahriman is strongly at home. This does not mean that we should not use electricity, for both Lucifer and Ahriman bring gifts as well as temptations: so much so that one can say—Without Lucifer, no Art; without Ahriman, no modern science. It does mean that inviting opportunities to misuse the forces of sub-nature will come, and have come. The atomic bomb came from intensive research in the realm of sub-nature, and the dropping of the first atomic bomb on Hiroshima was a triumph for Lucifer and Ahriman combined. Lucifer fostered pride in a great technical achievement and a wish to demonstrate it; Ahriman provided the means for so doing.

It is, of course, not only in the realm of sub-nature that science is exposed to temptations. The aim of the Ahrimanic Powers is eventually to cut off mankind from the spiritual worlds and to provide instead an extended life on earth, equipped with wonderful comforts and diversions. Science can unwittingly assist Ahriman in so far as its outlook remains materialistic, and in so far as the products of technology tend to make people dependent on machines, gadgets and things for meeting their daily wants and so to sever them from direct experience of the natural world and its fruits; also in so far as science tends to make the practice of medicine an impersonal science and less of a person-to-person healing art and skill.

In pursuing their purposes Lucifer and Ahriman are at war with the spiritual Powers ranged under the Christian leadership of Michael. During his last years Rudolf Steiner often spoke gravely of this conflict: he believed it would reach a climax at the turn of our century. The Michaelic Powers need the understanding support of human beings on earth, but they do not compel it. The directions taken by science during this critical period will strongly influence the course and outcome of the conflict.

* See the lecture given by Rudolf Steiner in Stuttgart on 2nd May 1923, and printed in the *Golden Blade*, 1951

Books and Journals

UNIVERSAL FORCES IN MECHANICS
by George Adams (Rudolf Steiner Press, 1977)

We are indebted to Stephen Eberhart for the labour he expended in translating this most important treatise. In 1956 and afterwards a small group in Dornach requested George Adams to present his ideas on theoretical physics, and the results are given in written form in this treatise.

In the first of three essays which comprise the book he shows that mechanical forces, the apparently least spiritual stock-in-trade of engineers, are only to be understood fully if their spiritual counterpart is reckoned with. Rudolf Steiner characterised the mineral realm as that governed by purely external laws, i.e. where objects only change in response to external forces, in contrast to living matter. Yet the external laws of leverage, change of momentum and so forth critically depend on the objects concerned—such as beams—retaining their form intact. The elastic forces of cohesion are essential if the outer laws are to be obeyed. George Adams points out that elastic displacements are always accompanied by small changes in warmth. These are indicative of the universal forces at work in the inner structure of the beams, etc., involved.

The justification for this follows from the development of a vectorial theory applicable to universal forces (i.e. etheric forces) which is grounded in the polarity inherent in projective geometry. Using planes instead of points of application he shows that such forces may be described by their representative planes. Normally the triangle law is assumed for statics as for kinematics, but whereas for the latter it is derivable by thought alone, Rudolf Steiner pointed out that for the former it is only derivable empirically. Adams shows how a vectorial trihedral-of-planes law for forces arises naturally from a consideration of the relation of planewise vectors to the 'infinitude within', which is the polar concept to the ideal plane at infinity. He relates the intensity of a force to the distance its representative plane moves in from infinity towards the polar-infinite point.

In this way he relates the laws of kinematics to normal space and those of statics to 'counter-space', as expressed by the polar aspect of projective geometry where planes play the 'primitive' role normally ascribed to points.

In the second essay he extends these ideas to graphic statics in three dimensions, and with their aid analyses the balance conditions for spatial frameworks. After working out the calculations in detail he remarks that the centre of mass of a body is the end point in a process of precipitation of earthly matter from its cosmic origin. That it 'dies'—becomes mineral—is precisely due to its separation from the cosmos, so that the latter reacts to external forces as though from the cosmic periphery. Adams suggests convincingly that a study of mechanical processes is aided conceptually by once again setting them in their cosmic context. Rarely does one encounter purely rectilinear or purely rotary motion in Nature; more often a spiralling combination of the two is to be found as in water movement, and the relation of the dynamic and kinematic aspects are well expressed by the linear complex and its associated null-polarity, as shown originally by Monge and Möbius.

The third essay makes much greater demands upon the mathematical knowledge of the reader, especially as many often difficult results are left unproved. It can scarcely be understood without a thorough knowledge of advanced projective geometry, and of linear complexes in particular. A summary will be attempted here for those lacking such a foundation.

It is a wonderful fact that the most elementary transformation of space, in which a straight line transforms into other straight lines, and planes into planes, is naturally associated with the so-called tetrahedral complex. The latter is a threefold infinitude of lines associated with the tetrahedron left undisturbed (invariant) by the transformation, being selected from the fourfold infinitude of all the lines of space. Just as a surface, formed of a twofold infinitude of points, may be selected from the infinity of points of space, so may a threefold infinity of lines be selected. It does not, however, form a surface! The elementary transformation of space we started with makes such a selection.

If that transformation is a combined uniform rotation and uniform translation (so that a point follows a helix as the transformation is repeated) then the set of lines it selects becomes a so-called linear complex. This has the special property that the lines of the complex in any plane form a flat pencil (i.e. they all pass through a particular point of that plane), while the lines of the complex through any point of space again form such a pencil, i.e. they all lie in a particular

plane. Imagine a sunflower in every point of space, the total set of sunflowers being all at different angles and orientations! The petals represent the lines of the complex, except that they would have to be infinitely long. There is a very fundamental connection between such a complicated set of lines and the simplest of space transformations.

Now imagine two skew forces in space, acting on some object. Their lines of action and magnitude can be shown to determine a linear complex. The significance of this is that its lines are just those lines in space about which the total moment of the two forces is zero. Also, for every line of space it can be shown that a linear complex singles out another line called the polar line of the first. The pairs of such lines are the lines of action of pairs of forces each equivalent in effect to the original pair. The remarkable relation of the linear complex to forces was known in the last century.

George Adams proceeds to show how the polar relationship between kinematics and statics that he already demonstrated in the second essay is expressed by the linear complex. He coins the words 'kineme' and 'dyname' (the latter after Plücker) to refer to the velocity/acceleration aspects of a body on the one hand and the impulse/force aspects on the other. The intimate association between the two, so well known in science since Newton, is expressed by the fact that both kineme and dyname are expressed by a linear complex in the form of the null-polarity it determines. The latter is simply the polar relationship between the points and planes of space established by a linear complex; the centre of each sunflower is the polar opposite of the plane in which its petals lie. It can be difficult to hold these apart in thought until one is used to the polarity. Essentially the relationship between points and lines established by the complex expresses the kineme, and that between planes and lines the dyname.

One of the most beautiful results of the book arises where George Adams enables us to escape from the cause-and-effect view of Nature expressed by Newton's laws of motion, and instead to see the phenomena normally associated with such a view as polar responses arising out of the null polarity, or 'archetypal space screw', they share in common. Thus a force system acting on a body determines a null-polarity dyname, and the associated kineme null-polarity accounts for the response, i.e. acceleration. "The mutually polar correspondence (as when e.g. a point calls forth its polar plane and vice versa) *is more like a 'remembrance' of community and an harmonious behaviour arising out of this.*" (page 46).

Naturally the question of how energy is involved in this interaction must be treated. It is known in mechanics that if the motion of a body is constrained to accord with a particular kineme (e.g. to follow a spiral path) then there is a fourfold infinity of polar-complexes which, as dynames, can do no work on that body. The totality of those polar-complexes yields the same complex as that of the kineme, except in polar form!

The concept 'warmth distance' is then introduced as the energy relationship between a kineme and a dyname, being zero in the above case. In some sense, the more work imparted to the body in the course of the 'equalising' of kineme and dyname, the 'further apart' they are, the 'distance' being related to the energy.

The full discussion of mechanics is related by George Adams to three polarities, with respect to: firstly the 'ur-screw space' (as discussed above in connection with virtual work); secondly the eigen-quadric of the body; and thirdly the absolute quadric determining the metric properties of space. These polarities are much clearer in non-Euclidean space, and the discussion continues for mechanics in 'spherical space' i.e. Riemannian space. The beautiful possibility is exhibited of rhythmic variations in space itself, perhaps reflecting cosmic rhythms. Truly vertical and egg shaped kinemes can then arise. The question is necessarily open from a theoretical standpoint, as in conventional cosmology, as to which kind of space we actually inhabit. Observation alone, coupled with a suitable framework of thought, can settle such an issue. It is pointed out that if space is not Euclidean an experimental consequence would be that a body would not necessarily have the same inertia along each of its principal axes!

The essay ends with a useful synopsis (not copied here!)

The book well repays the effort involved in its study, laying the foundation as it does for further research into 'universal' (i.e. etheric) forces.

N.C. Thomas

A NEW SCIENCE OF LIFE

by Rupert Sheldrake (Blond and Briggs £12.50)

This is the book which so disturbed the editor of *Nature* that an editorial asked whether it should be burned—perhaps a measure of its importance? In a short dialogue with Sheldrake on BBC radio's 'The World Tonight' he pleaded with biologists to confine themselves to orthodox science in the search for the underlying explanation of living organisms. Dr. Sheldrake, who read Natural Science at Cambridge and later specialised in biochemistry and cell biology, has abandoned the mechanistic approach in favour of morphogenetic

fields which act through time as well as space. He believes that by a process which he calls 'morphic resonance' the form and behaviour of organisms is influenced directly by the experience of their predecessors; and that the same process is at work in chemical systems. He quotes experiments, e.g. showing an increased rate of learning in successive generations of both trained and *untrained* rats, which are consistent with this effect; and suggests various ways in which the hypothesis could be specifically tested.

This book should appeal strongly to those concerned with the hypothesis of etheric formative forces. While Sheldrake does not move in precisely that direction, he does argue cogently the possibility of formative forces not recognised by present physics. His theory has received some attention in scientific journals despite its unorthodoxy. In chapters on unsolved problems of biology, the genetic theory of heredity, and neo-Darwinian evolution, he pin-points weaknesses and contradictions in mechanistic biology.

In the end Sheldrake returns to physical causation, though of a new kind. Morphic resonance is not a metaphysical but a physical proposition. While action across time and space is unlike any known type of physical action, he says, it is not inconceivable that electromagnetic fields could be derived from the morphogenetic fields of atoms. The fitting of parts into position within the developing organism is accompanied by a release of energy "usually as heat, and thermodynamically spontaneous". The hypothesis deals only with the repetition of forms, not with the reason for their appearance in the first place. He specifically leaves open the question whether the first cause is, for example, chance creativity in matter, or a transcendent creative agency.

Brian Stockwell —June 1982

THE FIELD OF FORM

by Lawrence Edwards (Floris Books, 1982)

Just before his death, George Adams realised the importance of a fundamental geometrical form, the pathcurve. After his death research into this realm was carried on by Lawrence Edwards, who had worked with Adams for many years. Eventually Edwards started publishing the results of his ongoing research as a series of articles in the American journal *Mathematical-Physical Correspondence*. *The Field of Form* is an edited, partly re-written collection of these articles, together with some material not previously published in the *Correspondence*. It is a book of clarity, warmth and enthusiasm, without any superfluity of words.

The Preface, Introduction and Chapter 1 make it obvious that the non-mathematician is warmly encouraged to read the book and will be able to appreciate the contents.

Chapter 1 raises certain philosophical questions, such as 'What is straightness?' Edwards relates straightness to man's experience of unity and to the fact that in the algebraic equation of a straight line, both the independent and dependent variables are raised to the power one.

Some geometricians regard projective geometry as consisting solely of collineation and correlation, and in fact Chapters 1 to 8 all deal with collineation, whereas Chapters 9 to 11 deal with more sophisticated concepts—but even these arise from collineation.

The earlier parts of the book deal with perspective, simple projection, growth measure (hyperbolic involution), step measure (parabolic involution), and anharmonic ratios. There is here the first indication of how the infinite cosmic periphery brings order into the finite.

The transformation of a plane (triangle) into itself, one to one, is then considered. This generates a family of pathcurves. To characterise these curves, a parameter λ which is the ratio of two logarithms, is introduced.

Elliptic involution or circling measure, leading to the generation of logarithmic spirals, is also examined.

Three-dimensional path-curves are treated in Chapter 4. When two of the points of a tetrahedron containing pathcurves move to infinity and become conjugate complex, three-dimensional pathcurves, in the form of egg- and bud-like surfaces covered with spirals, are produced. These remind one of the pine cone with its spirals, and, in fact, Edwards did make his first test measurements on pine cones. The λ-value measures the harmonic relationship between the pointedness and bluntness of a pathcurve, one end becoming reciprocally more pointed as the other gets blunter. Flower bud inflorescences, leaf buds and 'simple' flower buds also give very good pathcurves, the petal edges falling on the pathcurve spirals around the buds. Details of how to measure the bud, taking wood sorrel as an example, and calculate the $\bar{\lambda}$-value are given, together with statistical testing of the result.

In general, the value of $\bar{\lambda}$ changes as the bud develops and finally opens, a $\bar{\lambda}$ climax being reached just before opening.

Pathcurves also occur in other areas of Nature such as birds' eggs and sea urchins.

Twenty-seven pages of the book are devoted to the heart and its rhythms. Last century a Scottish anatomist, J. Bell Petigrew, discovered that the left ventricle has seven distinct but related layers. Upon seeing this work, Edwards began examining the outer layers of the hearts of dead sheep and pigs. He found that treating the

right and left ventricles as separate interpenetrating pathcurves gave good results. He then obtained tracings of X-rays of a living human heart, photographed at 50 frames per second, which showed the inner seventh layer. Good pathcurves were obtained throughout the systole/diastole cycle.

A particular invariant element present at infinity in the plant bud pathcurves comes very close to the heart at systole (due to the assymetry of the heart) and sometimes nearly to infinity at diastole. A model for the seven layers of the heart during one beat is tentatively suggested, the invariant element for each layer breathing inwards at systole and relaxing outwards at diastole. In Edwards' words, "each heartbeat would fill the cosmos".

Departing from the purely collinear aspects of projective geometry, the author then describes his search for a pivot transformation, transforming the planar, negative spatial bud forms to the positive spatial, pointwise seed-bearing ovaries. The bud pathcurve turns out to be the transforming agent looked for, transforming a planewise vortex (negative λ) into the pointwise atomic form of the ovary. This section is more taxing mathematically but is a work of great insight and beauty.

Vortices in water are next considered. A whirlpool vortex, as when water flows down a plughole, strives to reach its point at infinity, whereas the vortex formed by stirring (as in Biodynamic preparations) forms a parabolic surface, its arms reaching to infinity in the opposite direction.

The last chapter relates form to life, and is the latest stage in Edwards' work. The evidence so far shows that there is good statistical correlation between the λ's of a set of buds and their water content (bearer of the life-giving etheric formative forces).

The book, which is very well illustrated with diagrams, is the result of many years of dedicated research and will be a source of inspiration to both mathematicians and those with an artistic feel for form. Every detail necessary to do one's own research in this realm is included for those who feel so moved.

Barry Christian (shortened)

TOWARDS

Towards is an increasingly impressive journal published in California twice yearly. From its first issue in November 1977, when it set out "to explore and make better known the work of Owen Barfield, Coleridge, Goethe, Rudolf Steiner and related authors", it has steadily developed its range and format. A central theme is the evolution of consciousness towards what Owen Barfield calls 'final participation'. There have been articles on various aspects of science, the nature of consciousness, imagination, poetry, literature, language; interviews with Owen Barfield, John Davy and others; reviews of important books, with replies from the authors. The last issue, dealing with aspects of Darwinism, includes an article by Barfield and an updating discussion with Norman Macbeth, author of *Darwin Retried.*

To use an ecological term, *Towards* occupies a unique niche. It is the only English-language journal of its kind, springing from anthroposophy but looking outwards to the world. It is obtainable from the publisher and editor, Clifford Monks, at 17417 Vintage Street, Northridge, California 91325 (annual subscription of 7 dollars including airmail postage).

Brian Stockwell - June 1982

BASIC SCIENTIFIC RESEARCH INTO THE "LOW DOSE EFFECT".

by Jean Kollerstrom.
British Homoeopathic Journal,
Vol 71, No.2, pp 41-47, April 1982

This short paper summarises a literature search (including, in some cases, direct correspondence with the authors) of non-medical attempts to establish that the very high dilutions familiar in Homoeopathy do have some physical effect, as measured by various forms of spectroscopy, or by effect on enzymic reactions, growth of single cells, seedlings, etc. Over 100 papers, published between 1950 and 1978, were scrutinised for statistical validity and reproducibility. Only three papers survived rigorous examination, i.e. the authors were able to repeat the work with similar results, and gave sufficient experimental and statistical details to enable a reader at least to evaluate the method for himself. Many authors were unable to repeat work which they had previously published. Of the three 'survivors', only one project has been repeated independently.

Jean Kollerstrom suggests that, if a project is well designed and the results are statistically highly significant, then failure to repeat this success does not automatically invalidate the first experiment. Hence, repeatability as a criterion of scientific method is questioned; this proposal requires careful examination. Or perhaps there is an 'idiosyncratic experimenter field' or some other as yet unknown factor.

Howard Smith

Was Rudolf Steiner Right or Wrong?

Lawrence Edwards

I think we must feel very grateful to Brian Stockwell and Hedley Gange for their excellent contributions on Saturn and the Space Probes.* The following up of these matters, in relation to the latest indications of modern science, is very important, and we look forward to hearing more.

In one paragraph, the question was raised as to whether Rudolf Steiner's knowledge of these things was correct or 'incorrect', and here I think we need to move with the most careful thinking. Was he 'right' or 'wrong'? We have to realise that this is by no means a straightforward question. There are some questions that cannot be answered by a 'yes' or 'no'. The classic case—'Have you stopped beating your wife?'—is only one of them.

In assessing the reliability of a seer's pronouncements we are faced with, at least, four questions: 1) Has he had a true and valid spiritual experience, in contradistinction to being misled by the vapourings of the predilections and prejudices of his unconscious soul state? But a spiritual experience is surely nothing less, and probably nothing more, than a confrontation with spiritual beings, beings who have a life and will of their own. If the seer is to retain anything for his personal possession, of earthly wisdom, he must next clothe the whole thing in words, whether these are spoken to another, or simply sounded in his mind's ear. And Rudolf Steiner has told us many times how inadequate the words of our modern language are for this purpose. He speaks of having a 'struggle with words'. So we have question No 2): Has the valid experience been validly clothed in words? In *Knowledge of the Higher Worlds* Rudolf Steiner warns us about this, and speaks of the dangers of premature encapsulation in words and the rigidity in our thinking which can follow from it. I believe that it could be possible for a seer to have a true and valid experience, to clothe it in the best words he can find, and then, due to their inadequacy, to be misled into a too rigid interpretation of his own words. I am not saying that this happened in the case of Rudolf Steiner, but I am sure that it is a very potent danger with most of us, and its possibility cannot be ruled out. Question No 3): Does the seer interpret his own words truly? Question No 4): Are *we* able to make a true interpretation of words spoken by someone we never met, seventy years ago, taken down by a fallible stenographer, unrevised by their author, and quite probably in translation? From the first valid and certain experience, to our final uncertain interpretation, we have a chain of correspondences, at any link of which uncertainty, and even error, can seep in, leaving all the previous part of the chain valid and true. How can we ever say just 'Yes' or 'No'?

I can envisage a being coming from another planet, who has never met a man, and who wishes to know what a man is. Then he confronts me. And as a result of this very real experience he says: "A human is a being who is composed of, and lives within, an organism of warmth". And knowing my own nature I know how true are his words. But they open more questions than they answer. What kind of warmth? soul warmth? warmth ether? physical warmth, measurable by a thermometer? Or a combination of all three? And when he says 'consists of' does he mean 'consists *only* of'? When considered as a physical being does a man consist *only* of warmth? And if one of his hearers comes to such an interpretation, how far can we say that he is 'wrong'? I know that the substance in me is in a state of continual interchange with the world outside. What was in me yesterday, yestermonth, yesteryear, is not in me today. If I *am* the substance that makes my body, then as an integral being I will not exist in a few weeks' or months' time. The person who wants to argue that the substance which makes up my body is not me, and that the organism of warmth, in which I live and have my being, will outlast it, and *is* my real being, can make out a good case indeed; in spite of the fact that from another point of view he can be proved incontrovertibly wrong.

Did Rudolf Steiner tell us that the gaseous body of Saturn is illusion? Did he not constantly stress that the whole tapestry of our sense-perceptible world is Maya—illusion? We only reach reality when we penetrate to the world of being which lies within it, and upholds it. But when I stub my toe against a rock I become painfully aware of the presence of this illusion. Because a thing is Illusion it does not mean that it is not There!

When such statements are made about the world which is to our hand they do not seem so

outrageous to us. But I am wondering whether our interpretation of this word 'illusion' varies subtly with the situation in which it is applied. Maybe it ought to; I don't know; but surely we should be aware of it. When the space probe stubs its cosmic toe we become so easily offended.

But the essence stands before us. Out there, in the cold depths of space, this probe has discovered a being of warmth—surprisingly, unpredictably and almost inexplicably, a being of warmth. The fact that such a thing *was* predicted, over seventy years ago, must be put down to a triumph of anthroposophy. Whether the real and true being of Saturn also carries round with it a carcase of substance, and whether Rudolf Steiner's words indicate that he did, or did not, know about this, are matters of great interest that should be followed up in the excellent way in which Messrs Stockwell and Gange have started, but they should not be allowed to hinder our view of the central truth involved.

* *Science Form* No.3, pp.10-12

THE PRIME NUMBER DOMAIN - continued from page 15

Inspiration, transform your thinking and feel the hidden essence behind it, yet not lose a jot of the clarity and consciousness you begin with".

Such attempts, however, often yield interesting spin-offs. There follows an account of such an attempt.

Consider the Fibonacci series 1, 1, 2, 3, 5, 8, 13, etc. but apply it to modular arithmetic. Prime moduli, of course, are the most fundamental.
Examples :
Modulus 2] 1 1 2 (Carrying each sequence further merely repeats it)
Modulus 3] 1 1 2 3 2 2 1 3
5] 1 1 2 3 5 3 3 1 4 5 4 4 3 2 5 2 2 4 1 5
7] 1 1 2 3 5 1 6 7 6 6 5 4 2 6 1 7

An examination of all prime numbers ⟨130 yields the following as regards the number of figures (terms) in each row.

a) 2, with three terms, and 5, with as many as twenty terms, are special cases.

b) for prime numbers p ending in a 3 or a 7 the number of terms is either i) 2(p+1) or ii) 2/3(p+1)
Giving i) are p = 3, 7, 13, 17, 23, 37, 43, 53, 67, 73, 83, 97, 103 and 127
Giving ii) are p = 47, 107 and 113

c) for prime numbers p ending in a 1 or a 9 the number of terms is either iii) p-1 or iv) 1/2(p-1).
Giving iii) are p = 11, 19, 31, 41, 59, 61, 71, 79, 109
Giving iv) are p = 29, 89 and 101

It would appear that, apart from the primes 2 and 5, all primes occur in one of four groups (but I have not examined primes ⟩ 130). But why?

Of course the great characteristic of the Fibonacci series is that

$$\lim_{n\to\infty}\left(\frac{u_n+1}{u_n}\right) = \gamma_1 \text{ (the golden ratio) } \gamma = \frac{\sqrt{5}+1}{2}$$

The numbers 2 and 5 are essential constituents in the being of the number γ. Is that why they are exceptional in the modular Fibonacci sequences given above? The groupings b) and c) may be formulated as $10n\pm3$ and $10n\pm1$ groupings. Here again $10=2\times5$. Is this significant?

A final remark about the impulse behind this article—it springs from the inspiring indications given by Rudolf Steiner in a lecture in Stuttgart on 16th March 1921—the first of eight lectures on *Mathematics, Scientific Experiment, Results of Observation and Thinking from the Viewpoint of Anthroposophy*. Therein the method of moving from purely mathematical knowing to spiritual knowing is carefully described. A key step along this path is what I have referred to as *qualitative isomorphism*. The term 'isomorphism' is well defined in pure mathematics. When the transition from quantitative to qualitative is effected no less exactly by spiritual-scientific means, then inspired cognition will sound forth through what at first appears to be a 'nothingness', to which attempts to find individual character in each prime number always lead. But this very 'nothingness' can hold the same kind of moral force described by Rudolf Steiner in the second level of the Rose-Cross meditation in his book *Occult Science*.

The May 1982 Conference on Heredity

Emerson College, 15-16th May 1982

In his characteristically quiet but persuasive way, Dr. Bockemühl outlined the new approach in heredity which he is developing. As John Davy emphasised in an introductory lecture*, heredity is a field where science soon comes face to face with social and moral issues: so a fundamentally new approach in this field could have repercussions far beyond the bounds of this particular branch of science.

The first requirement along the new path is to develop ways of observation and thought appropriate to the study of living phenomena. This has long been recognised as a desirable objective, but Dr. Bockemühl has made an intensive study of it for many years, with particular reference to the plant realm, bringing in wider relationships, linking the form and growth of plants to meteorological processes, seasonal changes, cosmic influences and details from the spiritual researches of Rudolf Steiner.

There are essential differences between the several kingdoms of Nature—mineral, plant, animal and man. Recognition of these differences is a first step towards the development of modes of observation and conceptual activity suited to the particular realm under investigation.

A plant, like a crystal, has form, but the form of a plant is continually changing. At any given instant we see only one aspect of the plant. It is a general feature of living nature that forms appear, then disappear, to be followed by the appearance of new forms. In the life-cycle of a plant we observe leaf, flower, fruit and seed. In the seed, the plant has almost disappeared from physical sight. In leaf-formation there is also an 'appearance-disappearance' process: first simple, unformed leaves appear, next the formative principle manifests in leaves showing greater detail and then in the fully mature leaf.

To grasp the reality 'plant', we have to combine concepts arising from many different observations: both spatial and temporal elements are involved. We are concerned as much with thinking as with perception.

Dr. Bockemühl's investigations have included observations of plant-life in relation to the general study of the etheric realm as initiated by Rudolf Steiner, with special reference to the qualities of the four differentiations of ether (warmth, light, chemical and life ethers).

Four stages, or 'categories', can be observed in many processes of Nature. In the successive appearance of leaves along the stem of a plant, we notice first a small leaf-bud (the first impulse towards growth), next the whole leaf is present in an enfolded form (the Sketch), then finally there is an expansive phase as the leaf unfolds into the environment, and finally we have the fully grown leaf. The same four stages—Impulse, Sketch, Unfolding, Individualisation—are recognisable, also, in the life-cycle of the whole plant. There is also a connection between the four categories and the four elements—Warmth, Air, Water, Earth—respectively. In a wider context, the four categories are related to Will, Wisdom, Movement and Form (see *Occult Science* by Rudolf Steiner).

Dr. Bockemühl described experiments he has made with different Types of groundsel, using only self-fertilised seeds, and growing them in a variety of environments and at different times of the year. For each plant grown, a series of leaves emerging on the main stem was preserved as a representation of the plant's life from seed to flower. (See *In Partnership with Nature* by J. Bockemühl). Plants of the same Type grown at different times of the year showed different forms (although the influence of the Type was always apparent). Certain similarities were observed between plants of different Types grown at different times of the year: the spring leaves of one very nearly matched the autumnal leaves of another.

Conclusion

These and other investigations indicate that each plant has, *as potential*, all the formative possibilities of the species. The actual form which arises is influenced by the Type, the time of year and other environmental factors. There is a certain element of plasticity: it is not possible to know in advance what *particular* form will arise.

The seed of a particular plant provides the physical link between one generation and the next. In doing so, it limits (through its genetic configuration) the formative possibilities of the species.

This approach shows chromosomes, genes and the 'genetic code' in a new light. The information needed for the subsequent growth and form of an organism is not contained, physically, in the genes. Such concepts have been *added* to the genetic phenomena in accordance with a different, and less comprehensive, theoretical approach.

Hedley Gange and Glenn Charles

* Lecture on 'Genetic Engineering', 15th May 1982.

Some Approaches to the Problem of Potentisation

R.M. Morris Owen

It is as certain as any inductive observation can be, thus in practical terms quite certain, that homoeopathic potencies of particular natural substances do carry specific activities, which are manifested in particular therapeutic effects following correct prescription. This holds good for the thirtieth centesimal, the most widely used potency in ordinary homoeopathic prescribing in this country and indeed for vastly higher potencies. Hence arises the well-known paradox that we are getting clinical results, ultimately expressed in physiological changes, by administering preparations which could not contain even a single molecule of the material prescribed.

This paradox deeply concerns not only medicine but also basic science. Can the facts be accommodated at all within current scientific concepts? If not, how can we conceive the activity inherent in these preparations; what manner of extension of scientific thinking is called for by the fact of organic response to the evidently non-material activities?

We can go at least a little way within the concepts of current science and I want to try and explore how some of them might be involved.

Those who have, from Greek times onwards, speculated about the constitution of matter have either regarded it as a continuum, in principle infinitely divisible without loss of character, or as an assemblage of particles. Since the quantification of chemical composition in terms of combining, subsequently 'atomic', weights and the abandonment of the four-element notion, around the end of the eighteenth century, the particulate view of matter has been dominant, especially as a mental picture. It was still regarded by some eminent scientists as a useful imaginative and working model, but not a statement of reality, as late as 1906 when Einstein's paper on Brownian movement converted those who had still been sceptical about the physical reality of atom and molecule.

Thermodynamic thinking has however carried on in an abstract way something more like a view of matter as effectively a continuum; the effective presence of a substance in a physical system is considered for thermodynamic calculation not in terms of molecular concentration, but in terms of some 'potential' such as fugacity. It is therefore to thermodynamics that we may look for a hint as to how we should understand in scientific terms what happens when a substance is dispersed, by some means such as diluting a solution of it, beyond the Avogadro point.

Lewis and Randall's textbook *Thermodynamics* contains a passage which is of special interest in this connection (1):

"figures are sometimes obtained which are so small as to seem ridiculous ... and yet ... have as definite a significance as others which are capable of direct measurement.

Thus ... if 0.04 mole of silver cyanide are dissolved in 1 litre of 3M potassium cyanide ... the number of active molecules of silver ion is about ... 1/10 per cc. How ... can one say that ... there is any concentration of silver ion at all? We simply mean that ... at any one instant ... the chance of there being one molecule in any given cc is 1 in 10.

... if a suitable catalyser is placed in saturated water vapour ... at 25°C, the partial pressure of hydrogen is 250×10^{-28} atmospheres, which is equivalent to the pressure exerted by a single molecule in ... about one million litres. Yet this value has a precise significance and is certainly known within a few percent.

... if we calculate the vapour pressure of tungsten at 100°C ... the result, 10^{-105} atmospheres, would mean that the concentration of tungsten vapour would be less than one molecule in a space equivalent to the known sidereal universe ... we may utilise such a calculated vapour pressure in our thermodynamic work with the same sense of security as we use the vapour pressure of water."

The point is that a thermodynamic potential function, which can only be pictured in molecular terms as a probability, remains a valid quantitative statement of the effective presence of a substance in circumstances where there is no tangible material concentration in molecular terms. The potential function is in some way a

reality. If we apply somewhat similar thinking to the high potency dilution, we may say that there is still a presence of the substance, although it cannot be thought of as a molecular presence; in molecular terms it has taken the form of a probability.

To put it very crudely, the molecules which are pictured as having been present in the original solution must have gone somewhere, but could have gone anywhere, in the dilution. If we picture a stage where there are n molecules per ml, and $n<100$, and disperse 1 ml of such a solution in a volume of 100 ml of medium, any 1 ml sample of this further dilution may or may not contain one, or possibly a few more, molecules of solute but the probability of a molecular presence is the same for all samples and this is all that can in practice be said about their content of the substance.

In ordinary ranges of concentration we may think of the presence of the solute in terms of molecular concentration. As dilution progresses it becomes increasingly impossible to think in this way because once we reach a level where the number of molecules is not overwhelmingly large, we can no longer consider their distribution in different samples of a dilution to be effectively uniform. Our notion of the presence of the solute has gradually to take the form of a probability. What changes, as we go from 10^{-10} to 10^{-20} and on to 10^{-60} (C 30) and further, is not essentially the real nature of the solute presence but the way we have to think of it, so long as our minds are operating in terms of the kinetic-molecular picture.

The situation is not precisely analogous to those indicated by Lewis & Randall, where a time element can be brought in. When they picture even the highly attenuated presence of tungsten vapour in an atmosphere through the escape of occasional atoms from a metal surface and the return of atoms to it, they could to some extent save the particle picture by regarding their probability function as a time average of the real presence of atoms in the atmosphere about the metal. In the course of a second there could many times have been for a brief instant a free atom in this atmosphere. We can hardly think of the probability of a molecule in a millilitre sample of a dilution as a time average of intermittent real molecular presences, but even if we forego the picture, the probability, expressed in any convenient terms such as that of one molecule per unit volume, remains a real property or function which is the same for all samples of a dilution.

Thermodynamic potentials, which may be interpreted in probabilistic terms, are found for their own purpose more valid than molecular concentrations at much lower dilutions. As dilution progresses they become the only significant statement. There is no sharp point of switchover. There is at all stages a dual aspect, encountered in physical thought as mass concentration and energy potential (2). At one end of a dilution scale the former seems more real and picturable, while the latter gains in significance as dilution is continued. If the former is interpreted as molecular concentration the latter most readily accepts interpretation as a probability. Potentisation also is no single once-and-for-all development located at a sharp point on the scale of dilution. The property of potency is developed at low dilutions, such as C6 and C3 as well as at high dilutions, though its impact on the organism may be different at different points.

This shift of concept, between the mental picture of molecular concentration and a notion of activity whose formulation accepts a probability interpretation, inevitably reminds us of the metamorphosis which the concept of particle has undergone in physics. Here again the maintenance of a particle picture of the constitution of matter necessitates interpreting formulae in terms of probabilities. Apparently some physicists are content to accept probability formulae as hard final realities while others, like Bohm, try to conceive a deeper immaterial reality behind them. But the present fact seems to be that these apparent probability formulations express the hardest form of physical reality that thought has been able to recognise.

The problems of theoretical physics are vastly beyond our immediate concern but there may be a significant analogy between the duality, the complementarity, of a system of particles conceived mechanically and a continuum which can only be conceived probabilistically, on one hand, and the chemist's duality, between mass concentration and energy potential, on the other. The chemist's potentials represent essentially the active aspect of substances, manifested in physical and chemical interaction, and they apparently remain valid in conditions where the mass, representing the passive or inert aspect, simply disappears. If we consider chemical and associated activities to be already manifestations of cosmic in-fluence, it would not be too far fetched to consider thermodynamic potentials as being in some sort of continuity with the mode of functional presence of a substance in a medium which can carry the properties of homoeopathic potency, for we should also be considering these properties as cosmic in-fluence. We could perhaps think of them as present in some way at all stages

in some latent form.

It is generally believed that mere dilution, attenuation of the material aspect, is not in itself an adequate means of liberating these properties. Steiner certainly taught that the stepwise dilution, with due succussion at each step, was essential, and emphasised the element of rhythm in this procedure.

Paracelsus defined the task of alchemy as the making of medicines out of natural materials. This required the separation and rejection of the gross matter, composed of the four elements of physical existence, and the isolation of a '*quinta essentia*', a specific active principle, which he sometimes referred to as a seed, of cosmic origin, nurtured in the four elements as in a soil. He seems to have thought mainly of distillation as the procedure required. He would for example prepare a metal such as mercury, for medical presentation, by distilling the metal or ore with weak sulphuric acid or other material, and repeatedly redistilling his distillate. Modern scholars have commented that his final preparations could hardly have contained any of the substance they purported to present. We may add that there was of course a certain quantifiable probability of single metal atoms being carried through the operations. Anyhow Paracelsus' reputation as a brilliantly successful physician implies that his preparations were effective.

If we consider the physico-chemical analogies between the dissolved state and the gaseous state, these two procedures of expansion by serial steps reveal a certain affinity. In Paracelsus' routine there was an alternation of expansion in distilling and contraction in the condensation. Hahnemann appears to have set out on his course of serial dilution primarily as a means of reducing the toxicity of his raw materials, but he later came to a sense that his procedure liberated a further activity, which he called the 'conceptual essence'. There is some possibility that his later thinking was influenced by a study of Paracelsus' writings.

We may almost certainly take it that Hahnemannian potentisation depends on the stepwise dilution being accompanied by intense succussion of fluids or trituration of solids. At each step in dilution a small quantity of solution of a certain concentration is actively and rapidly dispersed through a large volume of medium, forming once again a uniform solution. In the absence of shaking such dispersion would take place spontaneously by ordinary diffusion. This process however depends on the difference in concentration between the stronger and the weaker regions of the solution and slows down as the difference decreases, thus approaching the final state of complete uniformity asymptotically. Uniformity of composition for practical purposes may be reached relatively soon, but from a certain abstract point of view it is possible to say that absolute theoretical uniformity is not attainable in finite time. By human and mechanical activity the process of mixing is driven to full completion in perhaps a couple of minutes. Time after time in the operation the spontaneous course of inorganic nature is foreshortened; a potential tendency is driven to complete realisation. I have spoken of this in terms of concentration because this is how we most easily picture it; in fact we are making these forced changes in a potential of activity.

Nature offers us something to compare with the foreshortening of a potentially infinite duration. The growth of a plant stem, giving rise to leaf after leaf, often showing progressive change in form and diminution of area, seems to be intrinsically capable of going on for ever. In flowering that whole implicit future is foreshortened, telescoped into the basis of seed formation. This foreshortening is not an intrinsic necessity of stem growth; under certain cultural conditions, such as over-richness of soil, it may not occur.

There is no existing physical concept for what we do when we force completion in a short finite time of a process which would spontaneously run a slower course and approach completion asymptotically. There cannot be many situations other than the dilution of a solution where we have the opportunity of this sort of interference.

Potentisation involves a series of forced expansions of solute volumes. The notion that these expansions are driven to a completeness unattainable spontaneously in finite time requires some qualification. In shaking we disperse layers or streams of solution in the diluent and ultimate mixing is still dependent on diffusion, though as shaking progresses the streams of solution are becoming less concentrated and the medium they spread in is already a solution. The finer and fuller the succussion, the more remote the dependence on diffusion becomes.

A dissolved substance diffuses through a volume of solvent under the same laws as a small puff of vapour expands by diffusion to fill the space of the containing chamber. This process could also be forced by stirring. Either process could be accelerated by raising the temperature but the asymptotic character of its approach to completion would not in principle be altered by

this. In so far as succussion is able to bring the process of mixing to completion we are doing something we could also do by heating and also pushing it that last bit further.

Physically the mechanical activity of shaking must be dissipated in heat liberation. The entropy of the final uniform solution is higher than that of the the starting point of, say, 1 ml of solution placed in 99 ml of medium. Can we conceive of some physical or quasi-physical function attending this transformation of mechanical work into the forcing of a spontaneous process, somewhat in the way that a change of entropy attends it? It would be in a way an opposite or complement to entropy, representing a value for the organisational element in the mechanical work done, which disappears from physical consideration when the energy of mechanical work is converted into thermal energy.

Considered in bulk terms dilution with succussion does not involve the alternating phases of contraction which appear in Paracelsus' operations. There is no means of contracting the volume to which a solute has been expanded short of boiling down the solution or fixing up a system which would selectively withdraw solvent osmotically. We must however note another aspect of the Hahnemannian operation in which contraction does alternate with expansion.

An immense creation, destruction and recreation of surface takes place may times in a minute or two of succussion. The obvious surface is a medium/atmosphere interface in the dilution of fluids; in trituration there is in the grinding together of particles of mineral and medium something more complex, but equally a perpetual creation of fresh interface. Once again we have the theme of expansion, now alternating, or rather interwoven, with contraction, at least in work with fluid media, and the expansion is in a two-dimensional realm.

This may be more relevant than the volume expansion with which it is associated, if we are concerned with in-fluence from the cosmic periphery, where George Adams' geometry has taught us to think of activity as existing in planes rather than centred on points. I remember Dr. Lehrs explaining to me that the entrance of etheric activity into manifestation in the material realm occurs through surfaces: "People" he said, "try to conceive of adding a fourth space dimension to account for effects beyond the physical, while in fact they ought to subtract a dimension." How else indeed could we think of planar activity operating in bulk matter, except through interfaces? I suspect however that we should not think of static interface in this connection but of nascent interface. This is abundantly present in potentisation and something rather similar is present in active living tissues where the surfaces of cells and cell organelles are ever in a dynamic state of chemical turn-over and rearrangement.

We may tend to think in casual terms of the action of a remedy. This may be appropriate in ordinary pharmacology but can have no meaning when we are no longer concerned with mechanical events, with the molecular model of processes in nature. The activity of potency must be considered in other terms, even though they too can be no more than the terminology of yet another mental picture.

I suggested recently (3) "that the remedial preparations of homoeopathy clearly cannot be operating through molecular pharmacology. They seem rather to carry 'information' in a manner whose physical basis is at present much discussed. The action seems essentially to be a 'communication', at some level between that of molecule-cell interaction and that of verbal and behavioural human interrelation." This was not of course an original idea; it was prompted by much that has been said and written by other people, particularly by Dr. Twentyman.

This sort of conception, or terminology, seems more valid in the realm of the living and can bring us to some sort of meeting with another line of scientific thinking. In immunology and genetics such terms as 'message' are now normal currency. They came in as more or less metaphorical importations from the use of the 'information' concept in communications engineering but are developing a validity of their own.

If we were to put our thought into this sort of form, we should find ourselves considering how we can conceive of a potency as a vehicle of a specific message, which the organism is attuned to receive when in a particular condition of disturbance.

The specificity of the message evidently derives from the nature of the material potentised. I have spoken hitherto rather as if considering solutions of simple substances. Most often in the preparations of remedies a natural material is used. From a chemical point of view this would be a complex mixture of molecular species, so that we should recognise its presence in the dilution to consist not in a single potential function but in a vast number of such functions, a difference rather like that between monochromatic light and the spectrum of a colour of

nature.

This complexity of composition might touch a central problem of biology which is focussed in the term 'organisation'. Some, like Monod, consider that the intimate structure of cells and the control of their processes arises in protoplasm as a spontaneous consequence of the chemical relationships of the substances associated together. Others would feel that organisation has to be thought of as a prior directive principle whose nature remains inconceivable. Either way its effective existence is maintained within the basic chemical composition. Can it remain within this material when the structures to which it has given rise have been destroyed through processes of extraction and potentisation? In a way it is just an extension of Monod's picture to suppose that it is still implicitly present in the spectrum of functional potentials which is all that is left of the material after potentisation, though it is a long extension and made with a different implication. Paracelsus might well have said that the cosmic seed is not necessarily annihilated by the disturbance and destruction of the soil.

I have suggested that the extra-terrestrial element of substance is already present in the thermodynamic potentials, or rather in the activity which they express, for as formulae they are simply the means of calculating the effects of this activity in physical systems. We might try considering a continuity between what is expressed in these potentials and what, through the course of potentisation, becomes the carrier of a specific message, determined by the particular nature of the substance or mixture, the composition of the mixture or the organisation implicit in it.

The message must at all times be somehow implicit in the material. Through potentisation it becomes somehow activated or amplified and communicable. This effectively seems to depend on the processes of forced expansion in volume and expansion of surface, which have energetic as well as mechanical aspects. Can we really form any positive notion of what goes on in these processes?

I can only think again of Paracelsus' analogy with the seed, and of the process of germination which follows the entry of moisture. We think of this as an alteration of the seed's connection with the cosmos, as the real-isation of this connection in form-creating terms, developing in earth existence living forms which continue in active interchange with the cosmos. The seed selects, as it were, its own formative determination out of a whole range of influence which is everywhere potentially active. The plant form, which it thus develops, is itself a 'message' which we aspire to read with sensitivity and understanding. Can we properly conceive of the operations of potentisation as something analogous, as developing in the functional traces of the material, the 'seed' of its physico-chemical activities, the particular, as it were 'selected', message which the organism may read vitally?

References and Notes:

1) Lewis, G.N. and Randall, M., *Thermodynamics*, 2nd Ed., revised by Pfizer and Brewel (McGraw Hill, 1961), pp 92-93.
2) Lewis and Randall speak of the mole as the capacity aspect and the molar free energy (redefined for numerical convenience as the 'fugacity') as the potential aspect of the substance.
3) Morris Owen, R.M., *Lancet*, 1980 (2), p.698.

Correspondence

Scotland and the Industrial Revolution

Dear Editor,

I enjoyed Hans Heitler on *Transubstantiation in an Atomic Age.* Accurate observation being essential for anthroposophists, can you please make known in a future issue that the 'English' engineer James Watt was a Scot?*

Watt's name is now best known to every user of anything electrical, of course—commemoration of the inventor of the first engines producing mechanical power from heat via steam pressure. His plan for production of his invention at Carron Ironworks, Scotland, fell through and the first engine, embodying his external condenser, was successfully built in 1774 in collaboration with Matthew Boulton of England who bought the Carron interest in that year. The new engine gave 75% better efficiency than Newcomen atmospheric engines. Watt became Boulton's partner in 1775, the first engine was sold (to John Wilkinson) in 1776, and William Murdock, also from Scotland, joined Boulton and Watt in 1777 to erect the engines on customers' sites.

The first engine converting to-and-fro motion to rotation was constructed and patented by James Watt in 1781. The sun-and-planet gear used is said to have been suggested by William Murdock. Patent restrictions prevented them from employing cranks. Watt went on to invent Expansive-working, the Double-acting engine, Multiple cylinder engine (Patents 1781-1785), Governor, Indicator, etc., and the first letter-copying machines.

Now a prime component of all piston engines, the Crankshaft was part of William Murdock's 1799 patent 'Bell-crank engine with long D slide-valve'. He invented the slide-valve, oscillating engine, and Coal-gas distillation, storage and lighting. He experimented with a steam carriage. Murdock was made a partner in 1810 at salary of £1,000 per year. He retired in 1830

Scotland has a remarkable connection with modern medicine and communications—logarithmic calculation, printing, smooth roads, pneumatic tyres, under-ocean cables, fuel-oil refining, television (invented by John Logie Baird), as well as steamships. Henry Bell, born at Torphichen near here, designed—and launched on the Clyde in 1812—the first commercially capable steamship, Comet, 28 tons. Bell had given liberal information about steam ship propulsion to an American acquaintance, Robert Fulton, whose successful version was launched on the Hudson River in 1807.

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* *Science Forum*, No.2, page 3.

(We are grateful to George Robertson for pointing out that James Watt was, in fact, a Scot. —Ed.)

GENETIC ENGINEERING

The Genetic Manipulation Advisory Group (GMAG) monitors industrial developments in biotechnology factories and also advises university departments and individual researchers on suitable safety precautions in this field. Some grounds for concern have been removed in recent years but possible danger areas that remain are: work with bacteria developed to manufacture large quantities of biologically active proteins, the use of live bacteria and virus vectors, and work with viruses that could cause tumours in humans.

The future of GMAG has been in doubt but its supporters urge not only that it should be retained but that its scope should be extended to include ethical problems associated with 'gene therapy', i.e. the altering of human genes to cure inherited diseases.

Hedley Gange

(Reference: *New Scientist*, 30th September 1982)

RADIO FREQUENCY HAZARDS

Recent new medical evidence concerning the biological effects of radio frequency transmissions indicates that new health and safety regulations, relating to these transmissions, may be desirable. The evidence indicates that resonant 'oscillations', at radio frequency, can be set up within the human body, frequencies around 500MHz, for example, being pertinent with respect to the skull. Equipment whose use would be effected includes walkie-talkies, cordless telephones and various types of cordless office equipment. (*IEE News*, October 1982)

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