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CONVIVIUM

(Michael Polanyi Newsletter)

"It is not by repeating Polanyi's words, but by doing what he did, that the very real power of his work will enter critically into the contemporary community of inquirers."
(Robert E.Innis in a review of Meaning,Journal of Religion,1977)

On 11th November 1978 the Department of Philosophy, University of Manchester renamed their philosophy seminar room the Michael Polanyi Seminar Room.The event was organised by Dr.Wolf Mays of the Department of Philosophy, who also read a paper, and the address was given by Professor T.F.Torrance of Edinburgh University (address included in this edition). Guests were welcomed by Professor C. Lejewski ,Head of the Department, and a plaque commemorating the occasion was unveiled by Mrs. Magda Polanyi. The dedication recalled the tremendous service Michael Polanyi had given the University of Manchester as Professor of Physical Chemistry,1933-1948, and as Professor of Social Studies, 1948 -58, and the numerous times he had contributed to philosophical discussions within the same room.

A conference entitled'Belief in Science and in Christian Life: the relevance of Michael Polanyi's thought for Christian faith and life ' was held in association with 'Convivium' at Cumberland Lodge, The Great Park,Windsor on November 24-26, 1978. The conference was chaired by Professor Torrance and a number of interesting and important papers were read. The papers from this conference should be published later this year as a book, when we hope to include a review of it in a subsequent edition of this newsletter.

William T.Scott of the University of Nevada,Reno, has undertaken the task of writing an intellectual biography of Michael Polanyi. After John Baker had intitiated the proposal that a biography be prepared soon, Robin Hodrkin suggested that Professor Scott is in a special position of being able to comprehend both the scientific and philosophical side of Michael's work, and Magda Polanyi took the initiative of asking him to take on the task. His professional work in physics has bordered in several ways on physical chemistry, and his concern for Polanyi's philosophy has issued in nine publications. He is on sabbatical leave for 1978-79, and has grant support from the National Endowment for the Humanities.

Professor Scott made a short but full 18 day trip to Britain last May and June, interviewing Magda Polanyi at length and 33 others for an hour or so each, returning with an estimated 40 hours of tape recording. Places visited included Oxford, Manchester, Cambridge, Nottingham, and Cardiff, with two stops each in Suffolk and London. While the primary archives are in Chicago ("It's a little easier for me to get to Chicago than to Britain, but not a lot", he says) arrangements have been made to have materials now in Britain deposited at the Bodelian.

The biographer urgently requests that copies of extant letters and other documents be sent to him at the Department of Physics, University of Nevada, Reno NV 89557. Any personal accounts of meetings with Michael anecdotes, impressions, information on others who knew him, and anything else that bears on how this extraordinary mind developed and on the roots of his thinking, would be appreciated.

Recent Publications

#693 Loyal D. Rue, 'Michael Polanyi and the Philosophical Task of Religious Interpretation', The Hartford Seminary Foundation (Connecticut), Ph.D., 1974.

#684 C.F.Mullins, 'Hermeneutical and Aesthetic Applications of the Thought of Michael Polanyi', Ph.D., Graduate Theological Union (California), 1976.

Both theses available in microfilm from University Microfilms International, 18, Bedford Road, London WC1R 4EJ.

R.A.Hodgkin, 'Freedom and Form in Education', paper delivered at the Standing Conference on Studies in Education, King's College, London, 1978. 'Definitions of Progressive Education.'

R.A.Hodgkin, 'Hayek and Polanyi', a talk on Radio 3, February, 1978.

Two papers criticising Polanyi's solution to the Meno paradox:

#64 M.Bradie, 'Discussion: Polanyi on the Meno Paradox', Philosophy of Science, 41 (1974).

#167 H.E.Simon, 'Bradie on Polanyi on the Meno Paradox', Philosophy of Science, 43 (1976).

Reviews:

#1369

David Holbrook, Lost Bearings in English Poetry (Vision Press 1977). Holbrook discusses the poet's problem of feeling confident in creativity, at a time when all human efforts to achieve meaning are felt to be 'sandcastles' ----- which the tide of time and matter will sweep away. He takes this theme from Meaning, by Michael Polanyi and Harry Prosch. He discusses the impact on modern poets of scientific ideas like entropy and evolution, and the whole matter-in-motion world picture as analysed by Marjorie Grene in Approaches to a Philosophical Biology, as

one which excludes man's moral being and his cultural achievements. Polanyi's assurance that it is not true that 'science says' that the world is meaningless is, Holbrook believes, of enormous importance to the creative artist, since it enables him to feel, in the face of the prominent ethos, that his efforts can be valid. He analyses the existential achievements of Thomas Hardy, W.B.Yeats, Isaac Rosenberg, and others to show what can be achieved in the face of the bleakness of'objective' science, and reveals the creative failure in those poets who have simply given in to the metaphysic of this bleak myth, rooted as it is -- as Polanyi declares -- in a misconception of science. Modern poetry, Holbrook argues, needs to rediscover the confidence in the creative powers manifest in Shakespeare, and Polanyi's emphasis on the imaginative powers, and all our 'tacit' powers as the root of our knowing, provides an important pointer to the way such confidence can be regained.

#1391 (book)

#1390 David Holbrook, Education, Nihilism and Survival (Darton, Longman and Todd,1977). Holbrook traces within the Humanities in education and the arts the kind of nihilism which results from the false goals of scientific 'objectivity' and the scepticism it generates. In this work he discusses both Marjorie Grene and Michael Polanyi, as philosophers who have exposed the nature and origins of this nihilism ---- as in Polanyi's Knowing and Being. Holbrook also points out how the nihilism in much modern art and the ethos that defends it has affinities with the egotistical nihilism of Max Stirner, the German philosopher and author of The Unique One and His Property (1845) rather with that of true philosophical anarchism. Polanyi has delineated the possible social consequences of nihilism in his essay Beyond Nihilism, and also the way in which the tendency originates in the failure to find man's proper place in Nature, as by the recognition of the involvement of the knower with the known, and the recognition of the consciousness that is exploring the universe. Holbrook uses the work of Polanyi, Marjorie Grene and others in the realm of existentialist thought and philosophical biology, from Abraham Maslow to Walter Weisskopf, to indicate where lie the clues to

our escape from nihilism ---- in the dicovery of new humanistic sources of values in philosophical anthropology.

David Holbrook points out that the latter book was refused the favour of a review in every quality daily paper and in every weekly except The Tablet. He writes that he was only able to get the Times Educational Supplement to review it by getting a number of educationists to protest at its refusal to review it.. In the educational press it was well received, and was reviewed by Dr. Thomas Hodgkin in New Universities Quarterly and by Thomas Merriam in The Use of English. He argues that the English press at the level of the higher journalism is determined to stick to its nihilistic paradigms, and its myths of the 'naked ape' and man's essential brutality, while the new humanists and enlightened progressives seem to be determined not to have their assumptions even challenged. He sees this as a dangereous and disgraceful state of affairs, and points out that while his recent novel was reviewed everywhere his books on such problems of culture and meaning are studiously ignored on the Radio and Television. He argues that this seems to indicate a new kind of indirect suppression in this area of debate.

Whose Review?

The Open Universe and the Free Society

T.F.Torrance

I have chosen for this address a theme which goes to the heart of Michael Polanyi's own intention when, in 1948, he relinquished his chair in chemistry for a personal chair in social studies, yet without leaving the ground on which empirico-theoretical scientific knowledge of the universe was actually being advanced. Unlike most philosophers of science, particularly of social science, he was a scientist; and unlike most philosophers he realised that philosophising can be done adequately only on the ground of active knowing of the universe if it is not to be trapped in a constant rediscussion of historic problems in philosophy which so often arose out of inadequate or erroneous knowledge of the real world around us. Michael Polanyi had thus to pursue a course which proved very lonely, for it was essentially pioneering, as it broke away from the tramlines of the self-styled 'professional'; but it was also remarkably prophetic, for the work he has done in the theory of knowledge, on the basis of the profound switch in rigorous scientific outlook that dates back to the essays of Einstein in the years 1905 to 1907, has proved astonishingly predictive of what is now taking place in the very foundations of knowledge. I take this opportunity to salute the University of Manchester for its wisdom in providing Michael Polanyi with the opportunity and freedom to pursue the deep epistemological implications of the scientific revolution in related areas of philosophical, social and human studies; and I salute the Philosophical Department of this University in marking their appreciation of Polanyi's great achievements, in dedicating a Seminar Room to his memory.

My purpose today is not to expound Michael Polanyi's thought in any detail but rather to set out his views of the profound integration between the advance of scientific thought and the society which supports it, and to show how subsequent advance in scientific knowledgegreatly reinforces and develops, and sometimes adjusts and corrects, the basic insights he elaborated.

At the bottom of all Polanyi's work is the conviction that the independence of thought and obligation to transcendent reality go inseparably together. the interrelation of freedom and order, or of order and freedom, is thus a persistent theme in his patient elucidation of science, philosophy, and society. Order without freedom is a destruction of order; and freedom without order is a desruction of freedom. This insight , as I interpret Michael Polanyi, is deeply rooted in his integrated understanding of science derived from his basic training as a physician, e.g. in his functional approach to order inseeking to understand how chemical and organismic relations cohere inwhat he called'biological mechanism', and his grasp of the indivisible unity between empirical and theoretical factors both in what we know and in our knowing of things. This was not simply a return to the old idea that the whole is greater than the parts, but a bid to understand things in the light of their natural cohesion which is inevitably disrupted by analytical methods andprocedures, that is, in terms of reasons and causes. Nature must be understood in the light of its intrinsic creative coherences and patterns, and correspondingly scientific discovery takes place through a creative integration in human thought correlated to the emergent orderliness in nature and not imposed upon nature artificially from some extraneous stance.

This does entail,of course, as is the case with general relativity, a profound recovery of ontology and objectivity, together ~~with a~~ with a dynamic reconstruction of physical knowledge. It also involves a critical estimate of merely analytical science and of its limited low-level validity, together with a rejection of determinism and objectivism which results from an unwarrented generalisation of the Newtonian or particulate abstraction of causal connections from fields of force. This is why Polanyi was so concerned to uncover and eliminate unwarranted assumptions - in fact perverse beliefs - going back to people like Laplace, Kant and Mach, and thus to liberate the philosophy of science from the destructive tendencies of positivism, and philosophical and social studies from being trapped in obsolete dogmatic fixations.

On the positive side, Polanyi's recovery of natural cohesion or integration carried him further and further into a wide-ranging rethinking of human knowledge in which the old damaging dualism deriving from Galileo and Newton, Descartes and Kant, are transcended, and subject-object relations are put upon a deeper, firmer basis. I do not wish to pursue that today, beyond pointing out that it led Polanyi to develop a single , continuously varying conception of knowing in which the gap that has opened up, through abstractive procedures, between natural and human sciences is overcome. It led him to grapple with the distictive character of natural connections and the way in which they are found to be coordinated in the universe independent of us. This gave rise to the realisation that the structure of scientific knowledge is analogous to the structure of the universe itself, so evident in the way coordination of different logical levels in the hierarchical structure of scientific knowledge reflects and corresponds to the stratification of levels of reality in the universe itself. This is a point at which the thought of Einstein and Polanyi came together and complement one another, not least where they make the claim (powerfully reinforced by the Gödelian theorems) that these levels are open upward but are not reductible downward, so that the more our knowledge of the universe advances the more we are convinced we are in touch with an objective rationality which transcends our actual experience and outruns our powers of grasping and representing it. This means that all our scientific structures that really bear upon the universe are ultimately indeterminate or open. Moreover, it is inevitable, Polanyi pointed out, that whenever we envisage the universe as an ascending hierarchy of meaning as a whole ,'our natural/knowing expands continuously into knowledge of the supernatural' (Scientific Thought and Social Reality,1974,p.129). That is to say, within this integrated understanding of the universe and its ascending levels of intelligibility, it is impossible rationally to avoid the ultimate question as to the relation of the universe to God as its transcendent ground.

This carries us well beyond our immediate subject for this lecture, but there are two ingredients essential to Polanyi's epistemic outlook upon the universe that I propose to single out for reflection: 1) Polanyi's conception of reality defined in terms of the objective power of the universe to keep on disclosing iself to us in still hidden truths; and 2) his conception of human community as the social counterpart to such a universe, embodying in its own development a creative life resting upon belief in the reality of emergent meaning and truth, and manifesting therefore, unsuspected possibilities. Let me expand this a little.

1) Through examining the way inwhich actual scientific discoveries come about in the process of empirico-theoretical inquiry. Polanyi reached the conviction that comprehension is similar in structure to what is comprehended. He found there to be involved not only a deep inner connection between scientific knowing and the universe, but between scientific knowing and society as well. There is a deep structural kinship in the kind of order manifested in nature, science and society. Hence, admittedly, Polanyi shares a fundamental concept with the Marxists, namely a 'symbiosis between thought and society' (Background and Prospect the 1963 preface to Science ,Faith and Society, p.17), but the difference between them is actually immense, in their radically different understanding of reality and science.

Marxism is a socio-political counterpart to a positivist and materialist notion of science, rooted in obsolete Newtonian determinism, and operating with a logical bridge between concepts and experience. Hence a Marxist correlation of science to social existence can force upon it, by logico-causal necessity, a community structure correlated with the isomorphic character of the universe conceived as a mechanistic system. Marxism attempts to over come the dualism in Newtonian thought, not by transferring the inertial system of time and space from the mind of God to the mind of man as with Kant, but by grounding time and space in objective material processes deterministically conceived. In doing so it seeks to achieve a unitary basis between physical and social existence for all man's

working beliefs and convictions. Thus in Soviet Russia a massive attempt was made to produce a logically coherent and integrated society which is causally and logically connected with the structures of the physical universe as they are defined in positivist science. That is why pure science (science for its own sake or science for the sake of the truth alone) had to disappear into technology and why the technological society had to reign ideologically supreme over all human thought and existence. But the king pin in this whole structure is knocked away when it is found that there is no logical bridge between concepts and experience, as Einstein made so decisively clear, and therein opened up the whole structure of science to the vast unbounded intelligibility (Verstandlichkeit) of the universe.

This is the point where Polanyi's philosophy came in. In wrestling with the problem of pure science in face of the Marxist rejection of it, he became convinced that no pure or genuine science is possible except on the ground of the acknowledgement of a truth independent of ourselves which we are unable to manipulate for our own ideological ends, or on the ground of a recognition of natural law as a real feature of nature which, as such, exists beyond our control. Pure science involves the unfettered freedom of inquiry and thought, but it is a freedom that is possible only on the ground of unconditional obligation to'the reality of truth' - i.e. to a'transcendentent reality over which we have no control. This set Polanyi the task of thinking out the relation between freedom and control, or what he came to call 'spontaneous order' in society as well as nature. The question had to arise from the side of pure science: W hat kind of society emerges as the correlate of pure science, and the unbounded, intrinsic intelligibility of the universe to which it is dedicated ? To the open universe disclosed by the advance of pure science there ought to arise something like the freesociety. But what is really meant by'freedom' ? The traditional concept of freedom, at least as it seems to have been applied in our socio-political institutions, reveals an internal contradiction in virtue of which freedom constantly betrays itself.

Polanyi's way of tackling the problem , characteristically arose out of his own empirico-theoretic scientific activity in chemistry and

crystallography. There were,he found, two basic kinds of order: 1) order which arises through limitations imposed on the freedom of components, of molecules or cells: and 2) order that arises as full scope is given to their mutual interactions. Both kinds of order have their appropriate place or occasion, and they may combine in the way mutually exclusive functions combine, each fitting into the gap left by the other. The deeper he probed into the natural cohesions and configurations, into the morphological structures embedded in the real world, the more he found spontaneous order operating within a relatively determinate framework, restricted but not determined by it. This is the kind of order we find in crystalline formations which spontaneously arise within a certain set of conditions, but it is a polycentric kind of order that cannot be induced or imposed. That kind of order is achieved through a natural equilibration of matter and energy. But in living organisms we also find a kind of spontaneous order which Polanyi speaks of as the function of living mechanisms: this is an order that arises on the ground of physico-chemical relations, but is not finally determined by them or explicable in terms of them, for it arises at the boundary conditions left open by physico-chemical relations and develops structural or functional principles of its own.

All this implies the rejection of the determinant basis of Newtonian mechanics, evident still in the natural selection theory of evolution, and involves the idea of a stratified structure of the universe which we noted earlier, in which different levels are held to be coordinated with one another in such a way that a higher kind of organisation spontaneously arises, which rests on a lower level of organisation without being wholly controlled or determined by it. The lower level of organisation must rather be seen as the limiting case of the higher and freer and more widely- ranging organisation. This is the kind of organisation, then, where freedom and order, spontaneity and structure are found operating together - where freedom without order ceases to be freedom and order without freedom ceases to be order.

That is precisely the kind of order, Polanyi shows, that is to be found operating in our basic acts of perception: in the spontaneous way in which our minds integrate clues and thereby enable us to grasp reality in its latent dynamic structures, which we inevitably lose or destroy when we analyse them into the constituent particulars of which they are composed. It is in this way that our epistemic activity takes place, in fundamental acts of cognition, in which spontaneous intuitive acts are involved within a framework of traditional beliefs, or under the corstraint of a set of rules or of institutions. But it is in this way also that Polanyi understands our most rigorous scientific and mathematical operations to take place - e.g. in theinterrelation between the formalisable and the non-formalisable, the mathematical and the non- mathematical,factors. It was along this line that Polanyi developed his understanding of scientific discovery, as neither a logical or a psychological act, but as an essentially epistemic act at grips with intrinsic yet unexpected patterns of reality. It is in this light also that Polanyi offered an account of the structure of science itself, including scientific institutions and scientific communities, in the course of which he became the champion of academic freedom in face of attempts that gathered strength after the second world war to impose State control upon scientific research. It was the clash between those who advocated a centrally planned order and those who advocated spontaneous order in academic and scientific institutions that sparked off Polanyi's determination to devote the latter part of his life to clarifying the foundations of freedom in science and society on the ground of his scientific insights into the nature of reality.

As it was indicated earlier, Polanyi held that both kinds of oreder, planned and spontaneous, may well combine, yet in such a way that each is correlated with the other at the boundary conditions where they are left indeterminate to one another. Nevertheless the constant emergence on level after level of new spontaneous forms of organisation, each richer in order and less restricted that that on the lower level on which it rests, makes

it clear that in the natural conditions of the universe the spontaneous development has and must have the primacy within the stucture of dual control that operates at each level of organisation. It is in this way that Polanyi expounds the kind of order that obtains in a free society, one in which spontaneity and social organisation combine, but combine in such a way that the social constaints yield higher orders of freedom. This is the kind of order that is found developing in the free yet orderly activity of academic and scientific institutions. Much the same applies to the pursuit of arts and crafts, and to the professions such as law and religion. 'All these areas of free interaction operate within a tradition disciplining them but also making room for innovations in the sorts of mutual adjustments and criticisms individuals make vis- a vis one aother's activities'. (Meaning, p.198) Order is achieved in human society by allowing people to interact with one another on their own initiative, subject only to laws which uniformly apply to all of them. This kind of order, on Polanyi's scientific analogies, he speaks of as 'Polycentric' and 'spontaneous'. But decentralised order of this kind arising from mutual adjustment cannot be brought about deliberately through a corporate body, nor can it be imposed prescriptively from a central planning authority. It belongs to the very core of this combination of spontaneous and social order through mutual interactions, checks and adjustments, i.e. by mutual authority, that time or temporal connection enters into it as an essertial inner coefficient, for the aggregate of individual initiatives can lead to the establishment of spontaneous order only if each takes into account in its action what the others have done before in the same context. Here, for example, Polanyi pointed to what Adam Smith called 'the invisible hand' in the spontaneous ordering of marketing systems, or to the development and operation of common law through sequences of adjustments between succeeding judges guided by a parallel reaction between the judges and the general public.

* [illegible]

There is no need to go further into this, but it ought to be remarked that this approach, by no means implies a laissez-faire concept of freedom - the freedom of mere self assertion - for that on Polanyi's showing, would involve a notion of freedom fraught by internal contradiction which leads into its very opposite in the destruction of freedom. All-important here are Polanyi's conception of the nature of reality, which far from being necessitarian or determinate, is characterized by internal freedom or spontaneity in virtue of which it constantly takes us by suprise; and the way in which Polanyi holds different levels to operate in cross-level coordination with one another: the higher level resting on laws obtaining at the lower level, but not finally determined by it but rather controlling the boundaries of the level below it through a richer andwider organisation which it is made to serve.

Doubtless there are aspects of Polanyi's account of spontaneous order which require correction and adjustment, as indeed happens in all areas of scientific and rational knowledge. But Polanyi is undeniably right in the broad thesis that a Marxist or indeed a Facist type of State is the social correlate to a determinist and mechanist conception of the universe; and that the totalitarian State arises logically from the denial of reality to the realm of transcendent intangible reality over which we have no control, but to which we are bound in rational obligation, and that when the transcendent grounds of free activities are summarily rejected, the State of necessity becomes the inheritor to all the ultimate devotion of man (The Logic of Liberty, p.47)). But he is also surely right in the claim that the epistemological and social implications of the profound revolution in knowledge that dates from the first decades of this century, when adequately worked out and appreciated - as we are far from doing yet - will yield or ought to yield as its counterpart a free society, in which spontaneity andorder combine to produce results which we cannot prescribe or anticipate.

How far is Polanyi's own scientifically based account of spontaneous order within the framework of reality justified by subsequent scientific developments? It is in answer to that question that we come to the main intention of this address. I wish to argue that both of Polanyi's main contentions as to the nature of reality, and as to the emergence of spontaneous order, now receive even greater support from the on-going revolution in scientific knowledge, in astrophysics and thermodynamics.

1) The contingent, non-necessitarian, nature of (physical) reality- even of its intelligibility.

Basic to this question is the problem of how to cope with time and motion in the actual subject-matter of science. This problem was raised in different ways by Newton and Leibniz, but classical physics and mechanics, operating from a point of absolute rest, end up with a static description of the physical world, leading eventually within that frame of thought to the later problem of position and momentum in quantum theory, which would seem to indicate that in spite of relativity theory quantum mechanics, at least in its Coppenhagen/Gottingen form, is only half liberated from the Newtonian dualist framework of particle and field. The difficulty evidently goes back to the fact that in classical physics time, regarded as an empty receptacle, is treated only as an unchanging geometric parameter externally associated with motion - it was not allowed to enter integrally into the substance of scientific subject-matter. We have a similar problem in classical and modern logic where time is externally braketed of from the relations of ideas and statements: formal and symbolic logic lack even a conceptual counterpart to four -dimensional geometry. So far as scientific description of the universe is concerned the problem is perhaps best seen in the fact that classical mechanics is concerned not with time as such but with acceleration of motion, for it is acceleration that can be represented in precise mathematical terms. Expressed in another way, it is idealised mathematisation that eliminates actual motion and thus time, and so yields a necessitarian or determinist view of reality. Granted that the application of the differential calculus to the universe of bodies in motion was intended to account for its dynamic nature, actually what it did do was to break down the trajectory of time into digital

timeless points whose succession is governed by necessitarian mathematical law. This was reinforced by Newton's translation of the differential character of the universe in terms of the axiomatic structure of Euclidean geometry which has to do with the relations between rigid bodies irrespective of time. What we require is a profound switch from kinematic to kinetic thinking, and an appropiate conceptual instrument to effect this change and the description of the physical world in genuinely kinetic terms.

Today, however, science is concerned with space- time in which time, as well as space, is regarded as a function of on-going processes in continuous and indivisible fields of force. We still have the problem of the duality of the particle and the field, although that is evidently now being overcome, for example in particle theory in which most of the so-called particles are recognised not to be discrete particles so much as energy-knots in fields of force and where the relations between particles are ontologically essential to the structure of the fields and the particles themselves - that is, to use a theological term, where we are forced to think in onto-relations. The hang-over from the past is still with us, even for example, in the immensely significant and scientifically fertile Schrödinger equation dealing with the complex function of position and time in wave mechanics which still operates with a form of differential equations - which of course does not invalidate it but limits it, even in the time-dependent form it is given, in our grasp and expression of the actual flow and movement of time. As Einstein once said, 'The De Broglie-Schrodinger wave fields were not to be interpreted as a mathematical description of how an event actually takes place in time and space, though, of course, they have reference to such an event. Rather they are a mathematical description of what we can actually know about the system. They serve only to make statistical statements and predictions of the results of all measurements which we can carry out upon the system.' (The Fundaments of Theoretical Physics', Out of My Later Years, p.104)

On the other hand, microphysical science has revealed that atoms and molecules and nuclei all reveal a history -that is to say, time enters into what they now actually are. Evidently, as V.F.Weisskopf has pointed out (in his presidential lecture to the American Academy of Science, The Frontiers and Limits of Science ,1975), that does not apply to protons, or nucleons and electrons which have no intrinsic properties revealing what happened to them in the past . Time or history is clearly embedded in self-reproducing structures from the smallest to the largest organisms, for their evolution is written into what they now are and are still in process of becoming. All this has to say that the history of matter enters into our scientific understanding of it.

This introduction of the element of time or history into the physics of nature has been greatly reinforced through the discovery in 1965 by Penzias and Wilson of the 2.7° K cosmic background radiation resulting from the incredibly immense explosion with which the expansion of our universe was initiated, but deriving from a period some million years afterwards when the universe was still in a state of near thermal equilibrium between radiation and matter (cf. B.Lovell, In the Center of Immensities, p.97f). The scientific and epistemological implications of this are very far-reaching. It means that in its progressive expansion the universe is never characterised by perfect thermal equilibrium, and that in this expansion time is allowed for many interactions leading to quite new features. (The significance of this we shall see shortly when we turn to consider recent changes in thermodynamics.) This expansion of the universe also implies that the universe is finite in time as well as space, and that the whole expansion of the universe must be regarded as a vast singular event - in fact, a unique historical event characterised by irreversibility or the arrow of time . This has the effect of smashing the old dualist disjunction between the accidental truths of history and necessary truths of reason, and calling into complete question the idea that science is ultimately concerned with timeless and necessary truth, for now it is evident that all scientific truths are as contingent as the universe itself.

now , of course, all modern empirical science has relied upon the fact that the universe is contingent. It is because it is contingent and not necessary (it might well have been other than it is ; it might not have been at all), that we can gain knowledge of the universe only by asking empirical questions of it - that is, through experimental operations. But the problem - and this is one of Polanyi's major insights which he shared with Einstein - is that when we start to formulate our knowledge of this and produce our generalisations we almost inevitably lapse back into necessaritarian modes of thought, confounding in the generalisation of a theory its comprehensiveness with what is universally and timelessly true, and converting temporal relation back into logico-necessary relation. Reality, as Polanyi has shown, is very different, even in the kind of rationality or intelligibility which it exhibits: it is such that even when we make our discoveries, nature suprises us and reveals patterns which we could not have anticipated from what we already claim to know. Nature is characterised by an unbounded range of freedom, an indeterminate depth of intelligibility, in virtue of which it has an unlimited capacity for disclosing itself in ever new ways and revealing ever new truths. It is in the context of that understanding of reality that all our academic and scientific operations have to be carried out, and all our human activities, social as well as artistic and intellectual, ought to be directed and organised.

In the general frame-work of classical physics there appears to be still a considerable obstacle to this view of reality and its contingent order - the laws of thermodynamics , which in their classical form tend to be the last hole of refuge for the positivists and determinists. But now even here we have a fundamental upturn in our ideas.

2)The extension and application of thermodynamics to open or non-equilibrium systems.

The empirical fact with which we have to do here is that when we move away from states of equilibration that give rise to the stability and permanence with which we are concerned in classical physics, we find not only, as the laws of thermodynamics predict, chaotic fluctuations and disorder, but quite unexpected and

suprising features: the spontaneous rise of new kinds of order.

Classical thermodynamics, which was long limited to the study of equilibrium states of physico-chemical systems in their interaction with one another, is concerned with entropy or the degree of disorder in such equilibrium or closed systems. Thus the second law of thermodynamics deals with the irreverible decrease in the measure of disorder or disorganisation in such systems or structures. That would seem to imply that the further back we go in evolution or the expansion of the universe we would expect to find less entropy and more homogeneity and order . However, it is an empirical fact the evolution of the universe in its orderly developments, and above all in the rise of biological structures, manifests increasing measures of organisation and order. How are we to hold these apparent incompatibles together ? Some kind of integration carrying out our understanding beyond that state of affairs has long been demanded. Now through the work of Ilya Prigogine of Brussels and others we have been shown that non-equilibrium can be a source of order, and we have been given an extension and application of the second law of thermodynamics beyond its classical or traditional frame of refererence to take in non-equilibrium or open systems in such a way as to account for the order which spontaneously arises our of apparently random fluctuations far from a state of equilibrium. (See Prigogenine, Nicolis, and Babloyantz, Physics Today, 25,1972;no.11,pp.23-28;No.12,pp. 38-44; P. Glansdorf and I.Prigigine, Thermodynamics of Structure, Stability and Fluctuations, New York,1971; I. Progogenine and G. Nicolis, Self-Organisation in Non-equilibrium Systems , New York, 1977, etc.) Here closed systems obeying the classical laws of entropy on one level are coordinated with open systems at a higher level characterised by a minimum notion which enable us to move from one type of description to another, from a thermodynamic to a dynamic description of it, in which time, needed for many interactions, is given its integral place within the orderly structures that spontaneously arise. Here we have a new type of time-dependent functional order coordinating space-time behaviour to dynamic processes within the system, but it rests nevertheless on the validity of connections holding at

the lower level which are subject to thermodynamic laws in the classical formulation - including thermodynamic irreversibility and the rejection by the second and third law of any perpetum mobile. (Incidently , this represents another nail in the coffin of a 'steady- state' or'oscillating' theory of the universe) (See I.Prigognine, 'Time ,Structure, and Fluctuations' Science, 201,1978,pp.777-785; and 'The Metamorphis of Science: Culture and Science Today', Abba Salama , IX,1978,pp.155-183).

Undoubtedly the hierarchical coordinations of levels of order involved in this approach throws a very helpful light on the evolution in the expanding universe: higher and lower levels of organisation and order spontaneously emerge which rest on the basis of physico- chemical relations at a lower level obeying classical thermodynamic law, while at the same time those levels of organisation are shown to be indeterminate. to use Polanyi's expression, in that they are left open and are controlled by the higher level at their boundary conditions. Here, then where we least expect it, precisely in thermodynamics scientific account can be given of how in the expansion of the universe new forms of coherence and order of a richer and more open-structured kind continuously and spontaneously emerge. This applies, of course, to the highest form of life, man himself, for within the perspective of natural science he is to be regarded as the product of such spontaneous self-organising order. But in this event it applies no less to personal and social structures of life which man develops: they are to be understood in the light of the same principle that governs the coordination of open-structured connections at a higher level with the more restricted structures at a lower level. Indeed, in accordance with this principle , as Polanyi used to point out, man must be regarded as one whose level of rational existence and behaviour is to be understood only if it is coordinated with a higher level beyond him - that is, with the transcendent level of God's interaction with man in the space-time track of the universe.

Be that as it may, what I have been concerned to show, in this brief and all too inadequate account of the extension and reformulation of thermodynamics, and its application to open systems

to account for the emergence of new, unexpected, unpredictable forms of spontaneous order, that we are given strong support for the earlier account of Polanyi, who must be said in a very remarkable way to have anticipated the discoveries which were recently acclaimed with the award of the Nobel Prize. A passing reference (Personal knowledge, p.384) to Prigogine's early thought shows how quick he was to appreciate the development that was to follow from the slender clue given at that time (1945), but there is little doubt that the structure of Polanyi's own creative developments carried within it pointers toward the fuller development of the thermodynamic programme. What lay behind that was his persistent conviction as to the contingent yet profoundly intelligible character of reality replete with inexhaustible possibilitites of order. As a scientist and as a human person of great sensitivity he opened his mind to those possibilities and allowed them to draw him away from stereotyped theories and formulations into a more open and dynamic theory of knowledge appropiate to such a universe. The fact that he anticipated in his own epistemological way the fresh discoveries we have been discussing, must prompt us to deeper examination of Michael Polanyi's own pioneering thought both in the foundations of scientific knowledge of the open universe , and in the extension and application of the kind of spontaneous order it manifests to human existence and social order in the free society.

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