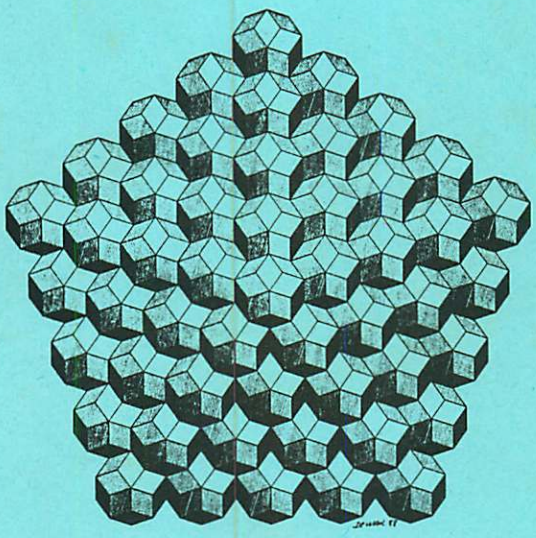
Symmetry of STRUCTURE

an interdisciplinary Symposium

Abstracts

I.



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THE SYMMETRICALLY IRREVERSIBLE UNIVERSE

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THE PROBLEM

Since the advent of thermodynamics in the 19th century, dynamic change in the physical universe has been known to be irreversible. According to the famous Second Law, heat can only flow from a hotter to a colder body and never in reverse; thus energies eventually dissipate and become unavailable for performing work. In time, any isolated system in the universe is bound to run down. The universe as a whole may be a system that does not receive energy from the outside; thus it is likewise bound to run down. That for a time it can--and apparently does--evolve is ascribed to the local concentration of free energy--and hence increase of negative entropy--which is always and precisely balanced by the global dissipation of free energy and thus the corresponding increase in entropy. This introduces a major asymmetry into our concept of reality. Order and complexity, while for a time building up in limited regions of space and time, tend on the whole to disappear, ultimately to be replaced by randomness and disorder.

Since the 19th century statement of the laws of thermodynamics, much more has become known about physical processes and the mechanistic conception of the universe, which views it as a closed thermodynamic system, has been questioned. But the global irreversibility of evolution in the cosmos has not been challenged. Even in the new cosmologies, order and complexity are expected ultimately to break down, although under varying conditions--either in the infinite reaches of an eternally expanding open universe, or in the superdense mass of a re-contracting closed universe. This study suggests that the conception of the irreversible loss of order and complexity is incomplete. It ignores the inverse process of the irreversible build-up, not of order and complexity in space and time but of the information on which such build-up is based in the spectral domain. Attention to this factor can reestablish symmetry in our concept of reality. This study shall explore the reasons why the factor is required, outline what it is, and how it can bring back symmetry into our concept of the evolving universe.

THE MISSING FACTOR

Still missing from the standard accounts of evolution in the sciences is the factor that would introduce the necessary guidance or direction into the otherwise random processes of universal evolution. The missing factor, in the view put forward here, needs to be conceived as a combination of field and memory, in other words, as a universally extended memory-field. Theories of this kind are actively explored today--we need only to refer to the earlier infamous but now already famous writings of David Bohm and Rupert Sheldrake. Fields and memory, the crucial components of the new conceptions, have been understood for some time. "Before Clerk Maxwell", wrote Einstein already in 1934, "people conceived of physical reality--insofar as it is supposed to represent events in nature--as material points, whose changes consist exclusively of motions...After Maxwell they conceived physical reality as represented by continuous fields, not mechanically explicable." This change in our conception of reality, he added, is the most profound and fruitful that has come to physics since Newton. [2]

In the so-called "new physics," developed in the last decades, the field concept is basic. In microphysics each particle is viewed as a singularity in a field that extends simultaneously to every part of the configuration-space. In field physics the metric of the spacetime field defines the trajectories and hence the behavior of the particles. Although there is no need of a material substrate such as "ether," without the assumption of continuous fields underlying and embedding the observed mass-points the new physics would be left with a world that resembled the grin of the Cheshire Cat: it would have observations, but nothing that the observations would be observations of.

The fields now known to physics cannot be reduced either to matter or to energy, although they may be generated by the one and may carry the latter. There are at least three major kinds of fields: matter-dependent energy fields; matter-independent energy fields; and energy- as well as matter-independent probability fields. Matter-dependent fields include the flow field of a moving fluid, the electric and magnetic fields surrounding bodies, the temperature field of the atmosphere, and the stress field within a compressed solid. Matter-independent fields comprise the gravitational field, the metric field of general relativity, radiation fields, the electromagnetic field in Maxwell's formulation (in which it does not reduce to Coulomb's law according to which the electric charges associated with matter particles generate the field), and the various nuclear fields. Energy- and matter-independent probability fields may underlie nonlocal interaction among quantum phenomena as well as the esoteric domains of human experience. The best understood instance of such a field is the state-vector or state-function field of quantum field theory. It consists of the probability distribution designated by the square of the state function 0 (phi). The thus designated field is independent of matter: the function 0(x) refers to a point in space without implying that any matter exists at x. The probability field is also independent of energy: there is no implication that at x there is any work performed by an energy vector.

If contemporary physics provides a basically sound description of physical reality (a realist assumption contested only by the Copenhagen school of quantum physics), the reality of the universe is rooted in various kinds of fields. Fields are even more fundamental in physics' world picture than matter and energy, since fields may exist without either matter or energy, but neither matter nor energy can exist without some field.

The field concept required as the missing element in contemporary theories of evolution is more than a mechanical juxtaposition of the currently known physical fields. Physics, after all, is primarily concerned with the physical universe, and that universe constitutes but one stage in the evolution of the cosmos. If the trans-physical --that is, the organismic, ecologic, psychologic and sociocultural-- domains are to be explained by the same basic laws of evolution as phenomena in the physical universe, the concepts currently emerging in the physical sciences need to acquire a wider interpretation. This brings us to the second element of the required concept, namely memory.

Memory is required to overcome the specious alternatives of chance and determinism in evolution. In theories of biological evolution metaphors such as "blind watchmaker" (Richard Dawkins) and "bricoleur" (François Jacob) have become popular; indeed, they are useful in countering teleological theories relying on final causes and preconceived designs. But metaphors of chance and randomness have limited applicability confronted with the overall spectacle of evolution not only in the biological, but also in the physical and in the human and social spheres. To gain a complete explanation, chance must be tempered with memory. The reason is that nature, not being guided by a final cause and not following a preconceived design, must be able to recall what has already evolved. Without memory the process of building systems and configuration from basic units and materials would have to start anew each time a chance disturbance destroyed what has already been assembled. This fallback, as Herbert Simon has shown, would call for infinitely more time than would be required if stable assemblies were created to be used as parts in the construction of more complex units. Since in nature any assembled system is subject to dissolution, evolution cannot build on the stability of assemblies that have already been produced. However, it can build on a model or blueprint of it. If we are to account for the evolution of order and complexity, we must assume that the pattern of already created assemblies is conserved and used over again. This does not convert nature as bricoleur into purposeful craftsman, nor does it make the blind watchmaker into fully sighted designer. But it provides the kind of information that enables nature to build systems upon systems in energy flows that constantly shake, and frequently destroy, the systems that have already been evolved.

The conservation of form, pattern, or "blueprint" in evolution suggests the presence of memory, but does not call for consciousness and intelligence. Memory, after all, is not uniquely associated with mind. The computer that processes the text now being written has memory and is unlikely to have mind, not to mention consciousness. Even a simple pendulum has a kind of memory: in each of its swings it "remembers" its initial displacement. The exposed film remembers the pattern of light of various intensity that reached it through the lens of the camera, and the film exposed in a hologram remembers the interference pattern of two coherent beams of light in the reproduction of a 3-D virtual image. And even the simplest of living organisms conserves the relevant impressions of its environment and displays that minimal flexibility that is connoted by the term "learning."

Memory in nature is not likely to be localized. For evolution to have taken the observed course, the conservation of the form or pattern of the already achieved configurations must be available at all points in space at all subsequent instances of time. This kind of memory is not supernatural: it is holographic. Holographic storage is entirely distributed, and it has vast storage capacity. Holograms store the inference pattern produced by intersecting beams of coherent light, one of which is scattered off the object reproduced. Since light from all parts of the object's surface is spread across the entire holographic film, all parts of the film receive information from all surface points of the object.

Consequently the recorded pattern can be retrieved from any and all points of the film: under proper viewing conditions the image appears even if only a small part of the film is viewed. Moreover, holographic media have staggering storage capacity; John Caulfield calculated that the entire contents of the U.S. Library of Congress could be stored in a medium the size of a cube of sugar. The distributed nature of the stored information, and the storage capacity of holographic media, suggests that the missing factor is a holographic kind of memory field. This does not mean that nature functions as a holographic apparatus, nor that the pattern conserved is a hologram. It also does not mean that the holographic medium in question is a film. The hypothesis is only that the conservation of pattern occurs in an extended field where the information is distributed, and that it occurs not in the domain where objects are extended in space and endure in time but in the spectral domain of multiply superposed waves.

Evolution in nature is no longer ascribed to the chance mixing of matter in blindly iterative interactions. There is now an explanation of the indeterminate but significantly probable emergence of consistent order and complexity in all spheres of observation. From the substructure of continuous fields emerge the quantized units known as matter; and from matter come the more complex configurations that surround and include us. The memory field transforms a blindly groping universe into an evolving cosmos without doing away with probabilities, violating the laws of physics, or assuming cosmic designs and other teleologies. The feedback of achieved pattern into incipient formative processes makes the cosmos self-evolving and our account of it conformant to experience.

In the memory-field universe symmetry is reestablished. Energy, as we know, is conserved in the universe and so is matter (baryon number). These symmetries of the standard conception remain valid. But in the standard account organization is irreversibly destroyed as global entropy irreversibly grows. The overall increase of entropy and decrease of order is not compensated: it is asymmetrical. According to the here presented hypothesis there is a compensatory process: the complexification of the fine-structure of the energy potential field. As the sum of ordered complexity in the matter-component of the universe decreases, so the sum of the information conserved in the memory field increases. The two processes precisely complement and compensate for one another. Symmetry is assured, even though the manifest course of evolution is irreversible.

REFERENCES

1. Ervin Laszlo, Evolution: The Grand Synthesis. Boston and London: New Science Library, Shambhala Publications, 1987.

2. Albert Einstein, The World As I See It. New York: Covici-Friede, 1934, p. 65.

3. For details, see the author's forthcoming Cosmic Connections: Steps to the Theory of the Whole. New York: Bantam Books, 1989/90.

4. Cf. H.C. Yuan and B.M. Lake, Nonlinear deep waves, in The Significance of Nonlinearity in the Natural Sciences. B. Kursunoglu, A. Perlmutter and L.F. Scott eds. New York: Plenum, 1977.

5. Geoffrey S. Chew, The analytic s-matrix. New York: Benjamin, 1966; and Henry P. Stapp, Space and time in s-matrix theory, in Physiological Review, Vol. 135B (1965).