THE SELF-ORGANIZING UNIVERSE

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Summary

This paper discusses the endogeneity of matter and the basic principles of origin, organization and dynamical aspects of all living matter. It concludes that underlying processes in examined biophysical phenomenon, as well as those in network thermodynamics, and social, economic and cultural, point conclusively to the underlying proclivity of all matter in the universe to self-organize.

1. Introduction

The word organization refers to alteration of structure and function within a body by matter, energy or information introduced from outside generally for the requirements of adaptation to needs and self preservation, while self-organization refers to alteration, control and guidance of the concerned body by a factor or mechanism within the body. Although it is most highly developed and is ubiquitous in all forms of living bodies, the phenomenon is universally present in parts or the whole of all that exists. In the universe, some of its various parts, or systems and planets like the earth, qualify for the term. The earth with its breathtaking blue color as seen from the moon and the resolvable morphologies and functionalities of objects for humans offers a grand spectacle of the power and the products of this phenomenon. In physical-chemical systems, in living systems, socio-biological, ecological, cultural systems including art forms, ethics, esthetics, the evolution of language, and semiotic communication, the principles of self-organization are strikingly evident. In some entities a critical analysis of this phenomenon by human observation of the whole and experimentation using the null hypothesis is not possible because of their extension on space and time. Consequently they are describable by more than one tentative view. In some situations a body may contain within it several smaller self-organizing systems, say, for example it may have biochemical reaction cycles.

Various approaches have been used to analyze the mechanisms of self-organization. They are however, predominantly thermodynamic. This commenced with I. Prigogine and his coworkers in Brussels and Austin (Texas). The focus most prominent in the field is associated with the dissipative structures. The general field developed by Prigogine includes multiple discoveries, including: nonlinear thermodynamics; reaction-diffusion processes; stability in chemical reactions; limit cycles; autocatalytic reactions; heterogeneous catalysis; oscillations; continuously stirred Belousov-Zabotinski reactions; oscillations in physiochemical systems; bifurcation in social systems (like two paths for ants to transport food); successive bifurcations leading to chaos; the Bénard convection in heating liquid under specified conditions; the Taylor hydrodynamic instability in rotating concentric cylinders; development of drosophila melanogaster; the development of complexity; and the birth and death model of fluctuations. Referring to Turing's and Lotka's work, he explained autocatalysis by chemical oscillatory systems and the regulation at the cell level, and subcellular systems level by such procedures as differentiation and evolution. In biologic systems, applications were made to cardiac rhythmicity, development of epileptic focus in the brain, and natural and immune networks with reference to cancer.

Results similar to Prigogine's have been obtained by Haken using analysis of emergent structures and formulations developed within a system of cooperative interactions of a large number of units. The results of the "working together" of large numbers of units have led to the name of synergetics. Synergetics does not treat external forces as given fixed quantities, but rather as obeying by themselves equations of motion. "Self organization" is described as what it is semantically, and it is resolved by including external forces as part of the whole system. In a set of multilevel systems one set may be so structured as to follow another subsystem, so to say it is "enslaved" by the other. If a variable, for example, force, is so constituted that the second subsystem follows immediately it results in the first system acting as an action parameter. When examined the action parameter may describe a degree of order, hence referred to as an order parameter. Synergetics has seen extensive amplification for generalized Ginzburg-Landau equations for nonequilibrium phase transition, instability criteria for soft and hard mode, laser action, Bénard and Taylor problems in fluid dynamics, elastic stability, generation of temporal and spatial patterns (another approach), reaction-diffusion from both deterministic and stochastic approaches to pure reaction without diffusion (i.e. a birth and death type situation). Among biologic problems addressed by Haken were those of evolution, morphogenesis and population dynamics. He introduced the possibility of phase transition in economics, the spirit of which guided development of "evolutionary economics", chaos, esthetics, and pattern recognition. A large literature has developed in synergetics, beginning from overall results of interactive subsystems.

Another field of activity was pioneered by the mathematician René Thom, employing catastrophe theory to classify and elucidate topological form, a very proper problem for self-organization particularly embryogenesis. Bifurcational formalism was developed for instabilities of optimization and design. They have been used for developing ideas on elasticity, and the imperfect sensitivity of perfect structure. Needless to say, implications of this in global organization of living bodies, socio-culture systems, and co-evolution of life have not been addressed by this approach. A similar situation prevails in fractals,that is, the generation of self-similar forms. Apart from contributions to design, and some aspects of esthetics, and results of self-similar profiles of biophoton emission, there is not much

application that can be seen in dynamic self-organization of dynamic and structural aspects. Deterministic chaos may have a partial role in the functioning of dynamic systems, but it does seem to offer abundant possibilities.

Certainly there is room to investigate chaos generated transitions and related structure, particularly in socio-economic phenomena and population dynamics.

A potentially fecund field for self-organization is offered by the notion of energy emission from biologic fields, chiefly by photons at almost all frequencies below ultraviolet to near D.C. Following Gurvich, and the extensive work of Popp, it seems they are emitted from DNA and the basic reason of their effectiveness may be in their coherence.

Certain physiological, pathological (cancer) processes, and a process of microbial gathering, may be correlated with emission of biophotons. They have thus been investigated to monitor and measure "Dark Matter" in the universe because of their extreme sensitivity which is thought to have very weak fundamental forces (Xiotas).

The effectiveness of biophotons in suitable situations is obvious. For their postulated source as DNA, if gene and domain wise specific, it is likely that biophotons are involved in the processes of growth and self-organization and are already an entity in relation to control and communication of several cellular processes.

If coherence is an objective criterion for determining the direction of evolution, the biophotons as a very coherent radiation may become very important. The coherence length may be an objective non-deterministic indicator of the direction of growth.

In studies using ideas of processes connected with excitations, Frohlich regarded Bose-Einstein condensations as an effective stimulus and communicating mechanism for control and emission. Counterparts of these processes in social, environmental, intergalactic phenomena are not at hand. Mishra regarded "response potential" (for proper response to a proper stimulus) as a basic "given" for organization and evolution.

In the living state the systems in the last analysis the stimuli, internal or external, show activity by impact of photons, phonons and excitation of all bosons, the end excitations. The three fields upon their mutual interaction can be shown to generate (non-dispersive) solitonic waves (and one dispensive solitary wave).

They create by non-dispersion and passage an energy network for a whole body connectivity. A solution can pass through another incompetent kind. This avenue for the whole organism may have implications for self-organization, control and communication and coherent activity. An increase in biophotons may increase output by light, oscillation, vibrations, sound, and electric fields.

Davydov proposed a type of excitation created by hydrolysis of ATP in myofilaments, which he proposed as a solution migrating across the length of the myofilament causing it to contract. This may, if true, explain contraction of some types of muscle filaments, but it ignores interaction with the global contents of the cell and therefore awaits refinement.

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Biographical Sketch

R.K. Mishra is a Medical Doctor and a Professor Emeritus of Biophysics at the All India Institute of Medicine in New Delhi. He is also the President of the International Institute of Biophysics in

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