

COMMITTEE I

Unity of Science: Organization and
Change in Complex Systems

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**REMARKS ON THE PAPERS OF
COMMITTEE 1 -- DR. ALONSO**

by

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ON THE ORIGIN OF THE ORDER IN THE UNIVERSE

by

R.U. SEXL

discussion

by

GIOVANNI B. SCURICINI

The report by R. U. Sexl presents many important and interesting aspects which could stimulate a lively discussion. I am not competent in many aspects of such a difficult and complex problem but I think that I may express my opinions ; they derive from my experience in a field of system science different from this one and I leave to other scientists more expert in cosmology to decide if they may be of any use.

First I have to say that I deeply appreciate that professor Sexl speaks of "order" and avoids to use the word "organization"; I think that this is not only a "word" problem (1). Nevertheless the meaning of the two words is, as you know better than me, very different on epistemological and semantic basis it happens very often to use one word instead of the other and this may rise some confusion.

Order is the result of a purely physical process devoid of any purpose or teleonomy, organization implies differentiated structures cooperating to reach an objective which may be far from the one to which the structures-deprived of the organizational links - should tend following the physical laws of thermodynamics.

I think that the problem should be dealt later on; for the moment it will be enough to remember that for instance Arecchi (1 fig. 3.1) the order is defined in relation with the correlation function; the same concept is expressed in the note to page 1 of professor Ayres paper that we shall discuss in session IV.

The second point on which I would like to draw your attention regards the model of cosmic expansion proposed by professor Sexl at page 14. May I suggest to consider a model which is a little more complex but that presents some not trivial advantages?

Forget for one moment the more sophisticated models based on relativistic relationships and on Riemann space and, following the Newtonian model, consider the universe in expansion (or a part of it) as a sphere. One may assume that - some time after the "Big Bang", when the relativistic effects are less predominant - the matter is flowing outwards in an empty space; consider now a cone of this sphere. Speaking very roughly we may look at it as at a nozzle: for symmetry reasons there is no flow - of matter, energy or information - through the conical surfaces: at a certain distance from the origin, when the radiation intensity is reduced and the matter is in a not ionized atomic status we may consider that inside - forgetting dissipative phenomena and shock waves- we have an adiabatic expansion. In these conditions, as a first approximation (forgetting the "Hugoniot" branch) we could consider that

the entropy should be constant; in practice irreversible processes would increase entropy. The diminution of entropy, or, which is the same, the generation of negentropy, could be explained considering that we are dealing with a mixture of gases (of different molecular weight) and more light particles like electrons and photons ; when certain conditions are verified it happens that the heavier elements are increasing their negentropy giving the excess of entropy - to respect the second law of thermodynamics - to the lighter particles that, being of higher speed, bring it away.

This is a normal practice in different research domain how it is very well known to the specialists of molecular spectroscopy and laser isotope separation. In laser molecular spectroscopy it is of common use to dynamically cool the gas in a free jet to deenergize the rotational degree of freedom; this allows to resolve very complex spectra and to find the individual lines .Some laser isotope separation processes adopt the same cooling procedure using a Laval nozzle.

In both cases the most efficient way of cooling is to add to the heavy gas a light one; simply speaking this allows to attain higher Mach numbers and then to reach lower temperatures. Looking a little more carefully to the process (2) it becomes evident that the light gas is behaving like an "order making" agent : the molecules of the heavy gas are not only accelerated in a preferential direction but their

speed distribution is narrowed in direction and in intensity. The reduction in transverse speeds of the heavy molecules affects the capability to create clusters in a way not easy to understand for the influence of many contrasting factors (relative weight of the molecules, nature of the light molecules, concentration, ...). Today one point under active investigation is the influence of radiation on the clusters formation process

I think that this simple and crude model, if duly investigated and modified to take into account the relativistic effects, could bring valuable information on the origin of order in the universe. This will be especially true if it would be possible to consider also the research efforts underway in other domains.

I would like, on this purpose, to draw your attention on a very recent issue of Los Alamos Science (3) which is devoted to "supersonic jets"; in a paper by M.L. Norman and Karl-Heinz A. Winkler it is stated that "non linear features of supersonic jet flow may explain the mysterious stability of extragalactic jets". Certainly here there are experts very well acquainted with the works being pursued at Los Alamos and at Garching, they could certainly go in a much more detailed discussion, on my side I would like to pin point a few aspects that I judge of a great interest also for people not interested to the scientific or technical details:

-there is a substantial difference in the particle paths in a shock tube - similar to the model of professor Sexl- and in a jet; in the former the particles far away from the tube remain stationary until the shock wave passes, in the second all the particles are moving

-the length of astrophysical jets equal to 50 to 100 jet diameter

-the "emission spectra of radio jets, which are continuous and polarized, are produced by synchrotron emission from a nonthermal population of relativistic electrons gyrating in a magnetic field" (any reference to FEL is purely fortuitous).

-the scale invariance of the problem - depending on four dimensionless parameters - allows to extrapolate the results of calculation from laboratory to cosmic dimensions

"x-ray data from satellites tell us that hot thermal gas pervades intergalactic space"

"at Los Alamos and Livermore...complicated multi fluid problems have been handled on large computers for three decades. Although multi-fluid problems are abundant in astrophysics as well, they have usually been approximated as one fluid problems"

Following these statements and the evidence of the photographs included in the paper I am feeling that to consider the multi component expansion in cosmic jet-like phenomena could bring some contribution in "order" formation of the universe. I do not know if this could be a global

approach or should be limited to restricted domains neither how far from the "big bang" this model can be applied; anyway it looks to me that the decrease of entropy in systems made of heavier particles undergoing expansion under a flow of radiation and of light particles may be taken in a certain consideration.

(1) Giovanni B. Scuricini, Maria Luisa Scuricini :
Cibernetica e Noetica : dal controllo delle macchine al
governo dei sistemi umani . Sansoni Editore 1985 Firenze

(2) B.B. Hamel : Relevant aspects of gas dynamics and kinetic
theory. Von Karman Lecture Series 82, 1976

(3) Michael L. Norman, Karl-Heinz A. Winkler: Supersonic
jets. Los Alamos Science, Spring/summer, 1985

MIND: MAPPING AND RECONSTRUCTION OF REALITY

by

PERCY LOWENHARD

Discussion

by:

GIOVAN B. SCURICINI

It was a great pleasure for me to look through the report of Dr. Lowenhard because he is dealing with many problems which are from some time of my peculiar interest.(1) In a time when everyone is speaking of artificial intelligence, I think that first and above all is necessary to understand how our mind is working. I am convinced that this necessity arises not only from a cultural interest but mainly by the problems related to the behavior of "Large Systems" ; up to now these systems were ruled mainly by the flow of materials or energy and the control was relatively easy. Certainly we have not to forget that the great revolutions are always born from new "ideas" which are generated in the "mind" by autopoietic or allopoietic processes: if God may be considered an external entity .

Anyway in the past the day by day evolution was ruled mainly by energy and material balance and it is not fortuitous that the optimum condition was considered the "equilibrium" which , from an information point of view is the "warmetode" (thermal death).

Today our system is based on information flow and elaboration and our mind is called any moment to take decisions and to make judgement in a very complex environment; the introduction of artificial intelligence

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systems could help to solve many problems but it will require that our minds are capable of mastering more and more complex situations characterized by shorter and shorter response time.

For me the most dangerous error is to attribute to artificial or living systems qualities beyond their capacities; this is the reason why in my book I have adopted the distinction between cybernetic and noetic systems while other authors are speaking of cybernetic 1 , 2, 3 or 4

Professor Lowenhard is very keen in specifying the capacity of the human mind and of the nervous system : starting from the first page when he points out that : a single retinal nerve cell has an information processing capacity equivalent to the simultaneous solution of about 500 non- linear differential equations . What I would like to point out is the "simultaneity" ; this capacity of the mind is very important when we consider that the decisions are taken by a man considering at the same time many aspects of a very different nature. On the contrary up to day a computer is working sequentially - or in parallel at the maximum - and its choice (I should like to make a distinction between decision and choice) is based on a well defined logic.

Another point on which I completely agree with professor Lowenhard is to consider the problems of life strictly connected with the problem of mind ; Von Neumann spoke of self-reproducing automata because he envisaged the

strict connection between reproduction and intelligence capabilities : only the reproduction allows to transfer the huge amount of information necessary to create the organization of a real intelligent system and to have its learning processes started. Certainly self reproduction is not necessary if a system of a higher level of complexity take care of the information transfer and of the first training.

There is one point on which I do not completely agree, is the use of words like structured, organized,... I am perhaps a little oversensitive on this point but I think that reviewing the paper professor Lowenhard could verify if the use of these words corresponds always to his intentions; i.e. I think not fully appropriate to consider that matter has the tendency to organize itself, surely matter, undergoing different kind of "auto-" processes, may forms the intermediate stable forms necessary for living systems to be born or to be sustained. Any way I consider that "self- organization" - strictly speaking may be applied only to living systems ; these two words imply in effect a "selfish" behavior and consciousness and the existence of a differentiated structure organized to perform a task different from the physical laws (second law of thermodynamics). I have taken the liberty to make this remark , purely formal, because I have highly appreciated what professor Lowenhard write about "self- consciousness", the "ego" and the three level of knowledge . I think that

this points have to be investigated very carefully purview of the difference with other authors like Edgar Morin (self and autos) and Varela who states that autopoietic systems are closed ones.

I would also to remind that the reconstruction of the real world by our mind depends on many parameters: someone physical, someone biological or psychological; I am not an expert of these problems but I think that the behavior of social systems is highly affected by such aspects as i.e. the ones examined by professor Tsunoda.(2).

From what I have said is evident that I perfectly agree with the final statement of the paper; this, I hope will make me forgiven for my too punctilious remarks about semantics.

(1) Giovanni B. Scuricini, Maria Luisa Scuricini :
Cibernetica e noetica , dal controllo delle macchine al governo dei sistemi umani. Sansoni editore 1985 Firenze

(2) Tsunoda Tadanobu : The Left cerebral emispher of the brain and yhe japanese language . The Japan Foundation Newsletter Vol VI /N 1 (April- May 1978)

(3) Tsunoda Tadanobu : The mother tongue and right-left dominance in the central auditory system . United Nation Conference SS-81 / CONF/801/6 Athens 16 March 1981

THE EVOLUTION OF EXTENDED ORDER

by

GERARD RADNITZKY

discussion

by

GIOVANNI B. SCURICINI

The paper from Professor Radnitzsky tackle with the most difficult problems of our society raised by professor Hayek : evolution and spontaneous formation of order. This is practically the verge of any study about system behavior; the sociopolitical system is of the highest noetic level because its evolution and morphogenesis are linked to the information processing by the minds of all human beings (1).

The problem today may not be solved in a quantitative way; the difficulty to find a solution depends on two aspects : an objective and a subjective one.

The first is related to the extreme complexity of the system itself and the impossibility to find some "rationality" to simplify it to a level to which our minds could grasp the real nature of the problems.

The subjective one depends on the lacking of real universal and invariant concepts - accepted by every one and valid anywhere- which could establish the common rules to try to simplify our complex world (2). In the past the great religions or the great school of thought had given a general reference pattern on which the humans could organize their social and economic life . This organization has

progressively changed to keep up with the system evolution and from the very simple ones - valid for small groups of individuals cooperating only for game and for harvesting- we have reached the relatively complex structures of our institutional states.

Many people, especially the young ones, are feeling that these institutions are no more adequate to solve the complex problems of our society which is more and more dependent on complex information processing and in which the oscillations have an amplitude that prevents the well known "linearization by small amplitude perturbation".

I think that this conference has the great merit to allow us to start a dialogue on the most recent and advanced theories; certainly to appropriate the new ideas brought up in these days require a time which goes much beyond the conference duration.

I certainly have no authority to make any general comment; notwithstanding I would like to express my concern to see that there is so little confidence on the ethical behavior of human beings: at the moment that in a free democracy is thought that no man have the moral qualities - honesty, probity, "disinteresse",- to entrust him with government power, I do not see any difference with the most extreme expression of materialism.

I think that a nation becomes a wealthy and respected state when it has a "constitution" that represents its motive idea. Perhaps I am too much a "platonist" but I

think that in a "noetic" system the decisions - which are very different from the choices of logic and cybernetic systems - depend very strongly on the bias that the "ideas" introduce in the minds of human beings. I do not think that the economic profit may be the only moving idea of our society; also without taking in any consideration philosophical ethics or religious beliefs, I think that, in account of the non linearities of the System and of its "auto" and "self" capabilities, it would be very easy and highly probable to undergo very severe spatial or temporal instabilities of any kind (economical, social, political..): these instabilities, due to cybernetic processes, may be governed only at the higher noetical level.

(1) Giovanni B. Scuricini, Maria Luisa Scuricini:
Cibernetica e Noetica, dal controllo delle macchine al
governo dei sistemi umani . Sansoni Editore Firenze 1985
Chapters 5, 7, 8.

(2) ibidem pag.9,

INTEGRATIVE CONCEPTS IN THE PHYSICAL SCIENCES

by
MAX JAMMER

discussion
by
GIOVANNI B. SCURICINI

I appreciate the way in which the professor Jammer's paper deals with the basic problems of physics and philosophy because for many aspects he confirms what I have written in these last few years.

Anyway I have to express my perplexity on one of the very fundamental points; in his paper professor Jammer discuss with a great competence of the different aspects of reductionism and asserts that: " the application of integrative principles is a necessary condition for the possibility of physics as a science". I perfectly agree with him on this point but I do not understand why he is not , if I have well understood his thought, giving relevance to the problem of non-linearity(1). If systems are normally non-linear - and linearization is only an approximation that we are introducing to simplify the problems - it follows , by mathematical laws, that we are not allowed to disintegrate the system structure or flows. If we split the first we affect - as Jammer point out very clearly - the organization; but if we split the seconds, we change the mean values and the characteristics of the system will be different .

I am personally convinced that the second aspect is more treacherous because no immediate effect may be perceptible - there is no rupture of symmetry or other visible effect - but the behavior of the system may be very different. Consider for instance the automatic processes, they are ruled by very small differences, to change the branch of the curve affected could bring a system which is unstable to be considered stable. This aspect may become much more relevant in the low stability systems - studied by Kolmogoroff, Moser and Arnold - in which any perturbation may change the branch of the curve that the system will follow in its evolution. The same kind of danger may be found in the singularities of the catastrophe theory : when higher order derivatives are equal to zero the unfolding of the catastrophe depends on the perturbation ; if we changed the amplitude or the mean value of the perturbation the behavior of the system would appear completely different.

(1) I. W. Sandberg A perspective view on system theory IEEE-TRANS CAS VOL 31, JAN. 1984, PP 88-103

SELF-ORGANIZATION AND TECHNOLOGICAL CHANGE IN THE ECONOMIC
SYSTEM

by
ROBERT U. AYRES

Discussion
by
GIOVANNI B. SCURICINI

The paper of Professor Ayres is so interesting that it would require to discuss it properly much more time than it is available here today. I was really doubtful if I had to make any comment, the discussion papers by Nicholas Georgescu Roegen and John Frederick Ollom are of such a level of authority that to participate in the discussion could be judged at least as presumptuous. Anyway the papers are so stimulating that I think we have to exchange our view especially to merge the different experiences we have got in very different fields.

First I think that we have to deal with the semantics of the title of the paper; surely in this case in my view it is fully appropriate to speak of self-organization: the economic system does include humans and then its behavior is surely ruled by what I call "noetics"(1) and then its structure have to be of a very high degree of complexity which presumes some kind of organization. On this purpose I think that the example made by Professor Roegen about the book invoice does involve the semantics of the titles and, in my opinion, goes beyond the concept of order and reaches an organization level; may I remind that for Shannon information is : data organized in a message.

Professor Georgescu Roegen points out that in his opinion Ayres takes too much in account the thermodynamics aspects and does not consider the man as an economic agent (in my way of speaking professor Ayres considers only the low cybernetic aspects of the economic system which can cause omeostatic or omeoretic behaviors ; Maruyama, or Busch, would speak of an active system of a Cybernetic level I or II . Surely this is much better of those economists who consider the economic system only as a passive one (Cybernetic level 0) dominated by the entropy law « (1) tab. 1 and 2» ; on this purpose Professor Roegen states that: "economic life transgress not only the inorganic but also the organic domain.

Professor Ayres says that in an isolated system entropy never decreases; this is well known and there is no doubt on the consequences when we deal with small- or strongly interconnected - systems. But in large systems - far from the "warmetode" - this do not prevent a local diminution of entropy ; when the dimensions of a system go beyond a certain limit the system may be no more considered a "unique whole" : first higher "modes" (more or less linked together) will arise , then subsystems (less and less coupled and more and more organized) will be born.

Who has been working with electronic systems or with , lasers is very well acquainted with the behaviors of active systems. No one today is wandering to see a microwave or a laser cavity full of ionized, or excited, particles making

very nice and ordered patterns. Surely in the cavity we are introducing negentropy and we are creating some kind of order; the excess of entropy is discharged to the environment. In such a condition it is very difficult to maintain a thermodynamic equilibrium, but I think that, generally speaking, thermodynamic equilibrium is a very nice abstraction very difficult to be found in real systems which, normally, are neither closed nor isolated.

So I consider that in real systems cybernetic O is the exception and not the rule; matter is always pervaded by energy and information and then is a domain of morphogenetic and evolutionary processes.

But professor Ayres speaks of self-organization of socioeconomic systems, not of order-formation ! then he has to take in account not only the cybernetic behaviors, but he has also to consider the "noetic" aspects of human beings. This is the key point , here is the " first cause" that originates professor Georgescu Roegen remarks. On my opinion a qualitative answer - not surely a quantitative one (at least for the time being)- could be found considering that Logic or Noetic systems can produce negentropy structured in complex information .

No wonder than the economic system , where the "agents" are continuously taking decisions , is self organizing: any choice or decision may bring a diminution of entropy because it does not follow the trend of the system established by the second law of thermodynamics.

The problem is that if the economic system is very large it could host many "modes"; this is the reason, in my opinion, why in "Large Economic Systems" we are far from a "General Equilibrium" and the discrepancies and the differences are always increasing.

The big problem we are confronted with today is: "how is it possible to maintain the effects of the "magic hand of a free market" which flattened the differences in the relatively small system of the past? how is it possible to damp the "spatial oscillations" and to maintain the positive global evolution? An electronic engineer should say: "how is possible to damp the higher modes of oscillation?"

The proposals to go back to simple systems, splitting the global system, or to stop the evolution are no answer to our problems; the complexification and integration of the world system are such that the "trend" is well beyond our will and decision power. Surely enough in our civilization do exist other means to keep up with evolution and to avoid the increase of discrepancies. In my opinion this can be found looking through our cultures to find reference values.

This brings up the importance of intelligence and thought as government instruments. It follows that is very important to ascertain the differences between the various kind of intelligences: natural and artificial ones. The differences have to be found in the level and complexity of the information processing and organization: we are certainly very far from the thermodynamic concept of a

simple negative entropy . On this purpose I consider as particularly interesting the studies performed at IIASA on inventions and innovations and their relationship with other economic variables of the system.