THE FRONTIERS OF SCIENCE AND SELF-ORGANIZATION

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Abstract.

In the first part of the paper it is shown that both the quantum physics and the science of mind and consciousness are going together toward a unique frontier of science, the sructural-phenomenological frontier. The problem of the phenomenological information unifies the two frontiers of the quantum world and of consciousness into one.

Still, this frontier might be not the ultimate frontier of knowledge. The structural-phenomenological frontier could be the last frontier of science but not of knowledge, if the realm of deep underlying reality could not be explained by science, perhaps only by some way of direct introspective perception which gives another type of knowledge. If so, the phenomenological might be more important than the structural in the economy of the entire existence.

Accordingly, three main realms of science and knowledge are to be considered:

- The structural realm;
- The structural-phenomenological realm;
- The deep underlying reality (orthoexistence).

In all these realms, self-organization processes are present.

To the question "what is structural" the author gives an answer based on the contrast with the phenomenological: All what is not phenomenological, not perceived as phenomenological or having phenomenological elements, is structural. On the other side, all what may be described in a formal way, for instance with mathematical models, is structural. This is so because the phenomenological in its pure expression is not formal.
What is phenomenological? Related to humans it is the experiential and qualia. It is, in general, a sensibility of matter, of a fundamental type of matter (informatter). This sensibility is a physical process and every elementary manifestation of it is also a phenomenological information. It is a phenomenological sense. In its own environment (informatter) the generation of phenomenological senses cannot be described formally, it is a non-formal process. Accordingly, phenomenology is defined as the domain of investigation, knowledge and practice of experience and phenomenol- ogical senses, in general.

It is proposed to continue to improve envelope structural-phenomenological theories taking into account the state of the detailed structural-phenomenological theories. The exchange of ideas between these two classes of theories was and will be fruitful. Recognizing the experience

and the phenomenological sense as scientific facts, recognizing the coupling between the phenomenological and the structural as necessary facts of reality, also between the phenomenological sense and orthoenergy, recognizing the non-formal information processing in the phenomenological realm and so on, with such elements might be built structural-phenomenological envelope theories (by analogy, these are equivalent to macroscopic theories in comparison with microscopic theories) of the generation of a universe, of the nature of life, mind and consciousness, even of a Fundamental Consciousness, and on their interactions.

In the last part of the paper some considerations are presented concerning the process of self-organization seen as a foundational principle of the philosophy of science and an ontological principle (Kafatos, Drãgãnescu). There are three general frames for the universal process of self-organization corresponding to the realms of science and knowledge defined by the last frontiers of science. There are also specific frames for self-organization, for instance, the non-linear dynamics in the structural realm. Self-organization being physical, informational or both, self-programming is considered as an important type of self-organization, for all the realms of existence, and also the guided self-organization which in the structural domain is used by the newest technologies for self-assemblies of structural parts and perhaps might play a role at deeper levels of existence.

I. Is the problem of consciousness the last great frontier of science?

Two important conferences are dedicated this year to the problem of consciousness (TUCSON 2000 and ASSC4, 2000). The organizers of one of these conferences consider the problem of consciousness is the last great frontier of science.

Of course, the problem of life, mind and consciousness is a very fundamental frontier of science, but not the only one. There are today two great frontiers of contemporary science: one to the limit of the last entities of the quantum world and the other to the limit of mental processes and of consciousness (DRÃGÃNESCU 1998 a, 1998 b, 1999). But, as it was suggested before (DRÃGÃNESCU 1985) these two evident frontiers might constitute a unique frontier.

At the limits of the quantum world.

Concerning the quantum world, although the standard description, known as the Standard Model, explains all known experimental data, being considered the theory with the greatest success in the history of science, this theory does not explain the symmetries on which it is based, uses a number of 19 arbitrary parameters which are not derived from any theory and does not explain gravity (KAKU 1994), although it unifies three of the four fundamental forces, excepting gravity.

Consequently physicists developed the theories of supersymmetry and supergravitation with a space-time with 11 dimensions (hyperspace) - 10-space dimension and 1 time dimension (being interesting that all these theories, up to the superstring theory, are using a one-dimensional time, that might have some fundamental relevance). These theories lead to the conception of strings, superstrings (the incorporation of supersymmetry into string theory) and p-branes (KAKU 1994, SCHWARTZ, DUFF 1998, GREEN 2000 a, 2000b, DRÃGÃNESCU 1998 a). All these are

forms of strings. They may be one-dimensional, two-dimensional membranes (2-branes) or higher dimensional entities (p-branes). The elementary particles are not point-like in space but have spatial extension, the strings having the dimension of the Planck length 10^-33 cm. At such dimensions "space-time cannot be treated as a classical continuum" (SHU 1994) and needs a quantum interpretation. Various string theories (KAKU 1994) use10, 11 or 26 space-time dimensions, but 11 dimensions are preferred today. Therefore, it is considered that real space-time has 11 dimensions "but all of these dimensions except the usual four are somehow compacted or curled up to a size comparable with the Planck scale" (SHU 1994). That is why the extra dimensions escape detection.

From the superstring theory can be derived equations of relativity of Einstein and the Standard theory of quantum mechanics. Michi Kaku observes:

"String theory therefore, is rich enough to explain all fundamental laws of nature. [...] It seems nothing less than a miracle that, starting from some purely geometric arguments from a string, one is able to derive the entire progress of physics of the last 2 millennia" (KAKU 1994, p.158).

The particles of the standard theory are vibration modes of the superstrings in an 11-dimensions space. The symmetries of the standard theory are consequences of the supersymmetry in the hyperspace.

The reality of superstrings was not experimentally proved and it is not sure that can be experimentally proved in a direct way (GREENE 2000 a, b). The superstring theory is explaining the known physics (quantum and relativistic), it is a theory of unification of fundamental forces known by the structural physics. Still it is not a theory of everything because it does not explain life, mind and consciousness. The theory of superstrings does not say which is the origin of superstrings. But it points, in the frame of the structural science, beyond the smooth fabric of space-time to a discrete world of packets of energy. As such, it is a structural theory because it neglects the phenomenol- ogical (see part II of this paper).

The deepening of quantum mechanics into the realm of strings shows that there is something more fundamental than space, time and superstrings that are generated by a deeper reality. This is a frontier of knowledge that may be seen as extended from the description of physical reality of the quantum world in a greater number of dimensions than the usual four, toward a deeper realm considered by some scientists as a pre-space-time described by algebra to be used below quantum theories.

Information.

The deepest realm is seen as a source of energy, but this alone cannot be sufficient because some form (information!) is necessary to give birth from deep energy to the quantum realm. This necessary information cannot be of the type known today by science. I considered this necessary information to be different (DRÃGÃNESCU 1979, 1985), namely of phenomenological type, having sense (a form of meaning, see also DRÃGÃ-NESCU 1984). I called it phenomenological sense or informaterial sense. It was considered of the same nature as the mental sense and therefore a connection was made between mind/consciousness and deeper realms of physical reality.

Recently, F. David Peat observing that "Toward the end of the 1980s David Bohm introduced the notion of Active Information into his ontological interpretation of quantum theory" (PEAT 1999), proposes that science accommodate Active Information as a new general principle alongside matter and energy. For him

"Information is connected to ideas of form and meaning and leads to questions that are being debated in consciousness studies..." (PEAT 1999, p.53).

I observed myself that David Bohm arrived at the necessity to use the concept of sense in the deeper realms of physical reality (DRAGANESCU 1990). Bohm thought in 1957 that under the quantum domain there is a sub-quantum domain, which is still mechanical but with laws of movement qualitatively different from the quantum laws (BOHM 1957), with different variables (hidden variables for the quantum level). Then he believed that the mechanical sub-quantum level might explain the quantum level, but he declared prepared to accept other hypothesis (BOHM 1957, p.99) if the mechanical model failed. Indeed, in his essays (written between 1960-1980) published in the volume Wholeness and the Implicate Order (BOHM 1980) the "implicate order" in the deeper level of reality than the quantum world is a source for both "physical" and "mental", using the same elements of this deep reality which are not in a mechanical movement, but in a "holomovement". In 1985, Bohm considers that it is necessary to conceive also an implicated superorder which governs the first implicated order and help it to organize, being the totality of all which organizes the parts (BOHM 1985, p.255); he considers also that the deep reality has senses, and matter, in general, has senses (for him action is a development of an intention beginning from a first sense and action carry the affirmation of a sense); the senses are, after Bohm, an ingredient of nature, to be found in the roots of existence(underlying deep reality) which are out of space and time (space and time are derived from the implicated order).

At last (after Peat), Bohm considered, toward the end of the years 1980, the senses as Active Information, a different form of infor-ma-tion than the structural information recognized by contemporary science.

"Active information connected with form and meaning (sense)" - which is equivalent with the phenomenological information of the deepest reality of existence (called also orthosenses in DRÃGÃNESCU 1985) - is a new principle, a new physical and informational concept, that science "is now ready to accommodate" (PEAT 1999, p.49) and indeed Peat is justified to observe:

"When ideas begin to come together in this way it suggests that a fundamental breakthrough may not be far behind. [...] Information is something that could play a significant role in understanding the nature of the physical universe and, at the same time, have a key role in the operation of consciousness" (PEAT 1999, p.49).

Information is, in some way, encoded in the wave function, or some sort of a field or form, or some set of prequantum algebraic relationships. Yet what information is encoded? One solution is that all information, about the entire universe is encoded, or enfolded, within the global form (PEAT 1999, p.53).

Indeed,"information would have an objective nature" (PEAT 1999, p.51), a fact that was sustained since 1979 (DRÃGÃNESCU 1979, 1985, 1990), having also a fundamental

ontological nature (DRÃGÃNESCU 1996, 1998). In a set of proposed foundational principles in the philosophy of science (DRÃGÃNESCU, KAFATOS 1998) it was shown concerning the condition of information:

"The assertion,

The nature of existence is both physical and informational (P2)

is a foundational principle of existence. This principle contains a complementarity of physical and informational parts, which are manifesting the entire reality.

Also, because information cannot exist outside the physical realm (which itself depends on the informational aspect),

the manifestation of nature of existence is mainly physical (P2v).

Information is contained within the physical, although it can develop itself independently, in various ways, in a great range of possibilities, and it can influence or guide/command the physical part. There is nothing outside the physical, or even the information.

Physical means material, matter, substance, and energy. Matter has different forms in the deep reality and in the universe(s) deriving from this deep, underlying reality. The content of matter in the universe, which may be substance, space-time, fields, etc., is provided by the deep reality with its own information. Although it contains a Fundamental Consciousness [...], in general, matter, with its information is self-containing [...], or there is nothing outside matter.[...]

Principle (P2) may be considered as a principle of an informational materialism in philosophy. This does imply dualism, albeit a very attenuated form of dualism, and there is no fundamental contradiction between information and matter, they are only complementary.

An important aspect of the entire existence is its energy. There is energy in the deep existence with specific properties. We may call it "orthoenergy". Quantum physics implies that the vacuum contains very large amounts of energy, which in fact is the energy of the deep reality, and which can manifest under an appropriate form in the universe. And all the quantum elements (elementary particles, or superstrings, or p-branes, and quanta of space) contain energy. The energy, present in the universe is the main support of its dynamics.

Therefore [...],

energy is an universal ontological principle of existence (P2a).

In the same manner,

Information is a universal ontological principle of existence (P2b).

[...] In deep underlying reality, the phenomenological infor-mation is developed through physical processes, and consists of both physical and informational aspects. The phenomenological information is a feeling, a kind of experience at that level, and implies multiple consequences: to cause the fundamental semantic laws of becoming [...].

In a universe the information becomes also structural (like digital information) or structural-phenomenological (as found in organisms, mind, consciousness).

Information is, therefore, a fundamental reality of all existence, and physics can accommodate it as a part of the science of physics only after the recognition of the existence of phenomenological (experiential) information."

The true information is the phenomenological information, that is the source of structural information (information that is not phenomenological). Here is an important frontier of science, important both for the generation of the quantum world and for life, mind and consciousness. The problem of the phenomenological information unifies the two frontiers of the quantum world and of consciousness into one.

However it is necessary to recognize that the main drive for solving the problems of the last great frontier of science is given by the research of life, mind and consciousness. Physics, especially quantum physics, tries to accommodate these.

The merger of the two frontiers into one.

The connection of the two mentioned frontiers into one is de facto recognized by a number of authors. Those who do not see the possibility of quantum physics to be a real participant in mind and consciousness phenomena are considering only the standard theory with Bohr interpretation. It is known that KALUZA 1921 and KLEIN 1926, 1927 developed the first hyperspatial theory. They used a fifth dimension to establish a single field theory that can account for the four fundamental interactions (forces) and also to unify quantum physics and relativity theory. James E. Bleicher (BLEICHER 1999) thinks that the fifth dimension may be necessary not only for a unified field theory (today 11 dimensions are necessary, as it was mentioned before), but also for explaining non-local quantum interactions, quantum tunneling effect, and more, life, mind and consciousness.

The fifth dimension may explain the quantum entanglement and Bleicher writes:

"The pattern of field variations in the fifth dimension, as characterized by this entanglement, is the extra something that distinguishes a living organism from a simple Newtonian mechanism. We can build robots and machines that are self-motivating in a manner similar to living organisms, but they are still not living entities. We can even design them with computerized brains so that they have the ability of self-motivation independent of direct human control as well as the ability to interact with their environment. But such Newtonian mechanisms could not be considered living because they cannot exhibit the five-dimensional entanglements characteristics of life. The linked field patterns, couplings or entanglements that are characteristics of living organisms are the life force, vitalistic force or elan vital that scholars and philosophers have sought for many centuries" (BLEICHER 1999, p.11).

After Bleicher, the more complex is an organism in the four dimensions, this complexity has a correspondent in the fifth dimension, and "a pattern of patterns evolves that we can call mind" (BLEICHER 1999, p.11):

"Mind is thus a still higher level of complexity than life because it represents the control of life. [...] Awareness can only be explained in physics as a point of view or perspective that can only come as the result of perception from a higher dimension of spacetime. Mind must therefore be associated with the fifth physical dimension. [...] Mind is the five-dimensional extension of the complexity of our four-dimensional brains" (BLEICHER 1999, p.11).

For Bleicher consciousness is a five-dimensional being. Nevertheless,
"We do not observe the fifth dimension directly and can only perceive the higher physical dimension through such

non-material qualities and quantities as memory, thought, feelings, and other paraphysical concepts" (BLEICHER 1999, p.12).

In antiquity, the Hellenic philosophers proposed various fundamental elements for the nature of all things: Thales of Miletus (624-548(or 5) BC, everything had come out of water); Anaximander (the world developed from the apeiron, something without distinguishable qualities, from which arose the opposites of cold and hot that produced the cosmos); Anaximenes (air was the origin of everything); Empedocles (mid-5th century BC, four material elements- air, water, fire, earth - are the roots of everything and two forces love and hate); Anaxagoras (5th century BC, infinitely small indefinite parts and nous (intelligence) which gives them motion once for all), Aristotle (384-322 BC, matter and form) etc.

In the last twenty years an effervescence of propositions emerged for explaining the nature of mind and consciousness in connection with the physical reality taking into account phenomenological processes (see DRÃGÃNESCU 1999 b where are presented also new ontological models proposed by Drãgãnescu 1979, 1985, Bohm 1980, 1985, Fred Alan Wolf 1984, David Chalmers 1995, 1996, Henry P. Stapp 1993, Ben Goertzel 1998, Richard Amoroso 1995-1997, Bleicher -mentioned above).

The main features of these models of the last twenty years, with all the detailed differences among them, are their structural-phenomenological nature (Drãgãnescu, Bohm, Wolf, Chalmers, Goertzel, Bleicher, Amoroso), their orthophysical character - that is the recognition of a deep underlying reality of the universe (Bohm, Drãgãnescu, Kafatos, Amoroso - see also KAFATOS, NADEAU 1990) and even the recognition of a Fundamental Consciousness in the model of the world (Kafatos, Stapp in some way, Amoroso, Drãgãnescu-Kafatos 1998).

Both the quantum physics and the theory of mind and consciousness are going together toward a unique frontier of science, the structural-phenomenological frontier. There is no barrier between the structural and the phenomenological, although the ways of coupling between them are still to be thought of.

II. Structural and phenomenological.

In essence, the unique frontier of the fundamental science today is the structural-phenomenological frontier (DRÃGÃNESCU 1995).

Still, this frontier might be not the ultimate frontier of knowledge. The structural-phenomenological frontier could be the last frontier of science but not of knowledge, if the realm of deep underlying reality could not be explained by science, perhaps only by some way of direct introspective perception which gives another type of knowledge. If so, the phenomenological might be more important than the structural in the economy of the entire existence. What we know and recognize, from the vast possibilities of the phenomenological information, is the experiential form of the phenomenological, as it is acknowledged by a great part of scientists today, the way in which the experience is felt by the human mind as qualia processes.

Experiential phenomena and qualia.

The recognition of the experiential phenomena is today a point of reference for understanding the reality. Galen Strawson (Department of Philosophy, Oxford University, UK) considers that "experiential phenomena are real, and are wholly physical" (STRAWSON 1999). He advocates a philosophical position of realist materialism:

"Realistic materialism, then, first divides the world into experiential and non-experiential phenomena [...] and it assumes that physical reality does not consist entirely of experiential phenomena" (STRAWSON 1999, p.24).

Both being physical he considers his materialism to be monist ("all things are of one kind - the physical kind", STRAWSON 1999, p.30). For him "the term materialist is in good order". "Experiential phenomena are wholly material in nature" [...] "There is such a thing as matter" (STRAWSON 1999, p.29).

Concerning the experiential and non-experiential properties he observes "we have no positive understanding how the two sorts of properties connect up" (STRAWSON 1999, p.25).
Indeed, this is, after recognizing the experience and in general the phenomenological senses, the main problem for a structural-phenomenological science, that is for science at present times. At the level of the human brain, the much-debated explanatory gap (DRÃGÃNESCU 1998 c) between structural and experiential processes is one example of the mentioned connection, not yet explained. Other connections, as for example between energy (deep energy) and phenomenological senses in order to give birth and maintain the quantum world, have also to be considered.

Strawson underline how complicated the situation seems to be:

"So we suffer from confusion in our imaginative picture of matter. [...] Physics can help us by diluting or undermining features of our natural conception of the physical that make nonmental phenomena appear utterly different from mental phenomena". [...] "Physics thinks of matter considered in its non-experiential being is a thing of forces, energy, fields, and it can also seem rather natural to conceive of experience or consciousness as a form of manifestation of energy, as a kind of force, and even, perhaps as a kind of field. The two things may still seem deeply heterogeneous, but we really have no good reason to believe this. We just don't know enough about the nature of matter considered in its nonmental being. In fact - and it had to come back to this - we don't really know to say that there is any nonmental being. All the appearances of a nonmental world may just be the way that physical phenomena - in themselves entirely mental phenomena - appear; the appearance being another mental phenomena" (STRAWSON 1999, p.26-27).

For Strawson,
Experiential =mental (= consciousness); non-experiential = nonmental.

What is interesting in Strawson's point of view is the emphasis on the experiential as a general property of matter, even as a possible form of matter.

One of the main properties of the living matter is considered to be the mental process (DRÃGÃNESCU 1985, 1995) which cannot be reduced only to the experience, although the experiential is an essential part of the mental process. The mental process is an elementary structural-phenomenological process. The structural part has an important role in the mental process, as it is, with evidence, of the brain whose structures of neurons, dendrites and molecules play an overwhelming role. Mind and mental are much more than experience or

phenomenological sense. Therefore mind and consciousness cannot be only phenomenological or experiential.
It is true that even the structures of living matter, the same being valable for the structures of nonliving matter, might have phenomenological senses at a deep level of their material constituents, but these structures have also energy which perhaps in itself is not phenomenological.

Concerning the various forms of manifestation of qualia, a thoughtful list was presented by A.G.Cairns-Smith (Glasgow University, Department of Chemistry, Scotland, UK). After CAIRNS-SMITH 1999, p.277, qualia (qualitative phenomena) are raw perceptual sensations (color sensations, smells...), interpretative feelings (of space, motion, recognition...), intellectual feelings (feelings of doubt, of certainty...), coercive feelings and sensations (hunger, fear, pleasures, pains...), volitional feelings and sensation (curiosity, urges, desires...) and [...] background qualia (moods, attitudes...).

Observing that

"Perhaps the most significant thing which qualia have in common is precisely that our hard sciences of physics, chemistry etc have no place for them [...] there is something deeply deficient about current physics and chemistry" (CAIRNS-SMITH 1999, p.272),

he declares that qualia is a

"bomb in the foundations of science [...]. What is so devastating about the qualia Bomb is that science ought to be able to deal with qualia. They are part of the physical world because they evolved; and they are part of the machinery of our behavior, along with ion pumps, action potentials, reflexes and so on" (CAIRNS-SMITH 1999. p.274-5).

He thinks that "feelings and sensations are yet another way of arranging the quantum energy. Like light they are produced by and interact with molecular matter- although so far only in brains" (CAIRNS-SMITH 1999, p.276). He thinks also that the producers of qualia (named by him "qualagens" are at root molecular, with protein molecules as key components (idem, p.276).
Qualia is phenomenological, but produced by the machinery of the brain that has many levels of activity, y compris, the molecular and the quantum levels, and its explanation will be possible in the frame of a structural-phenomenological physics and science, in general.

Structural-phenomenological envelope theories.

What is structural?
The new answer proposed here is based on the contrast with the phenomenological.
All what is not phenomenological, perceived as phenomenological or having phenomenological elements, is structural (1).
All what may be described in a formal way, for instance with mathematical models, is structural (2). This is so because the phenomenological in its purest expression is not formal.

An electron is structural as much as we do not take into account its phenomenological content because this is not relevant for its behaviour in most cases. This is the way in which physics

treated reality as being non-phenomenological, non-conscious, non-alive, therefore listening to the "principle of objectivation" mentioned by Erwin Schrödinger in his volume What is Life. Physics considered only a structural world and advanced very much in studying this aspect of reality, which in many cases proved to be extremely useful. But the principle of objectivation is no more so exclusive, because even the subjectivity has an objective part. Objectivity today means to consider also the experiential, or the phenomenological, in general.

Sometimes the separation between the structural and the phenomenological is not so sharp. For instance, an organisation of phenomenological elements forms a structure constituted of phenomenological parts. Such a structure could be treated formally, even with mathematical means. This may happen with the phenomenological behaviour of the deep underlying reality, and therefore a mathematical treatment of this reality is possible. This is very important because the possibilities of science may penetrate in the deepest realms of reality, even if it cannot attain completely the behaviour of every phenomenological part or of the phenomenological whole.

At the level of the universe, if the core of a particle or of a superstring is energetic and phenomenological (it is constituted of informatter and orthoenergy, DRÃGÃNESCU 1985) then the respective quantum waves have phenomenological components? Inside or out of the four space-time dimensions? Is it possible to have separated phenomenological (informaterial) quantum waves?
The structural-phenomenological quantum theory poses many problems and the efforts of Richard Amoroso concerning such a theory are relevant for these problems (AMOROSO 1995, 1997, 1998).

S-Science means structural science. SP-Science means structural- phenomenological science.
The SP-science will incorporate the S-science, but the latter alone is limited by a general principle of insufficiency and incompleteness (DRÃGÃNESCU 1991 a, 1996, DRÃGÃNESCU, KAFATOS 1998) to explain the nature of life, of mind, of consciousness and the nature of matter.

The structural world comprises structures, fields and waves. The interaction of the structures is realised by forces, or by exchange of virtual particles. The structural-phenomenological interactions (the connection problems) are eventually of another type, that we don't know yet the nature. With a structural vision of the world and with direct measurements based on forces it is perhaps impossible to prove the structural-phenomenological phenomena. One cannot study, for instance, the mind without studying at the same time the nature of life and the nature of nature. And there are very serious reasons to consider a deep underlying reality out of the space and time of our universe (not only of the 4 dimensions, but even of the 11 dimensions) in which are developed phenomenological and phenomenological-structural processes.

What is phenomenological?
Related to humans it is the experiential and qualia . It is, in general, a sensibility of matter, of a fundamental type of matter (informatter). This sensibility is a physical process and every elementary manifestation of it is also a phenomenological information. It is a phenomenological sense. In its own environment (informatter) the generation of phenomenological senses cannot be described formally, it is a non-formal process, although a general frame of tendencies for such

phenomena are perhaps present. This property of non-formal processing might explain the phenomena of intuition and creation of the mind and consciousness. Since there are manifestations with non-formal character and these are not predictable, in front of these the science might not completely penetrate the secrets of reality, and, as observed, still this ultimate frontier of knowledge could be surmounted with the means of non-formal processes themselves.

A detailed theory of mind and consciousness based on a structural-phenomenological ontological model, which involves also a quantum structural-phenomenological physics, is not yet available, but works for such a detailed theory are in progress (a presentation in DRÃGÃNESCU 1999 b). Never-theless, there are sufficient elements for trying to continue to build theories that envelop all the physical and informational details, which at last will be necessary to validate an envelope theory. For instance, recognizing the experience and the phenomenological sense as scientific facts, recognizing the coupling between the phenomenological and the structural as necessary facts of reality, also between the phenomenological sense and orthoenergy, recognizing the non-formal information processing in the phenomenological realm and so on, with such elements might be built structural-phenomenological envelope theories (by analogy, these are equivalent to macroscopic theories in comparison with microscopic theories) of the generation of a universe, of life, mind and consciousness, even of a Fundamental Conscious-ness, and on their interactions. It is hoped that the play between envelope theories and detailed theories will improve both categories of theories toward a better knowledge of reality.

III. Self-organization.

Self-organization is a foundational principle of the philosophy of science and an ontological principle (DRÃGÃNESCU, KAFATOS 1998). Foundational principles are more fundamental than physical theories (KAFATOS 1998).

The foundational principle of self-organization is a generalization of the scientific pioneering works of Prigogine (NICOLIS, PRIGOGINE 1977), Belousov (1958) and Zhabotinsky (1964, 1970) , Ashby (ASHBY 1947), Eigen (EIGEN 1971), Haken (HAKEN 1980) and others, of the researches in the new domains of complex adaptive systems, artificial life and other neo-structural domains (deterministic chaos, fractals, neural networks, cellular automata), also of the new philosophy of science that takes into account the phenomenological reality.

General and specific frames for the process of self-organization.

Self-organization happens at all levels of existence.

The following definitions were used previously (DRÃGÃNESCU 1991 b, p.97):
Grouping: settlement of elements (partially with order, partially without order; at the limit settlement with a general order, or a conglomeration without order).
Organisation: grouping with a specified order that presupposes some forms of correlation, cooperation or interaction among its elements.
Structure: organisation of elements that can be described by formal methods (mathematical, logical, and linguistic).

It may be seen that organization is a larger notion than structure. Not always an organization is structure or a system (structure and system are equivalent). Organization may be not always described by formal means if it contains active phenomenological elements.

In the same manner should be understood also the notion of self-organisation. Self-organization is not a structure if active phenomenological elements are present and change the organization in an unpredictable way, i.e. in a non-formal way. This may happen in the deep underlying reality (deep matter, deep existence, and orthoexistence), but also in any structural -phenomenological process.

It may be seen that considering the frontier of the structural-phenomenological science (which is an abstract frontier) and deeper the frontier of the deep underlying reality, there are two main frames for the process of self-organization. These may be called the general structural frame and the general structural-phenomenological frame of self-organization. Sometimes in the deep underlying reality the self-organization might be considered in a third general frame because of the phenomenological- structural processes, rather than structural-phenomenological, but it is perhaps too early to separate the second general frame in two parts.

Self-organization, as a process, may be physical, informational, or both physical and informational. Always self-organization takes place in general frame imposed by the level of nature in which it manifests or by some general rules or tendencies of this level.

A rich range of self-organized structures has as a specific frame the non-linearity of the structural interactions, namely the specific forms of equations and their parameters describing the non-linear dynamics of the process, or the rules of interactions.

Self-programming.

An interesting form of self-organization is the self-programming (KNUDSEN, FELDBERG, RASMUSSEN, 1991). Observing that at the structural level "most fundamental biomolecular processes can be interpreted in terms of computation" and that "a fundamental property of computation in bio-molecular systems arises from their ability to alter or program themselves", the above authors write:

"Self-programming occurs at all times and length scale in biomolecular systems. [...] The cell continuously programs and re-programs itself, and in the multicellular organisms this self-programming also occurs at the organism level [...]. Living systems can through a re-programming of some of their parts alter functional properties which are of vital importance for survival. Viewed over longer time scale this self-programming activity is also used to create new properties which are incorporated through the selection process of evolution" (KNUDSEN, FELDBERG, RASMUSSEN, 1991, p.224-225).

The self-programming takes place at the molecular level (nucleic acids, proteins, supramolecular structures - like the cytoskeleton and the cell membrane - by constructing new elements with such physical properties (shape and electrical charge) that have the possibility of new interactions with other molecules, having therefore new functional properties. Self-programming may indeed be seen as an important aspect of the evolutionary process.

In general, self-organization is a permanent dynamical process and as much as it is structural, in the sense given in this paper, is equivalent, after Church-Turing theses with a computation, including self-program-ming. It is true, Knudsen and co-authors consider that biological self-programming is different in nature than the Universal Turing Machine (equivalent with cellular automata, lambda- calculus, Post systems, recursive functions etc). At the molecular structural level any physical event is equivalent to a computation, the resulting self-programming is a computation: self-programming and self-organization are strictly equivalent. The only difference may be only the type of computation: algorithmic or conformational (which depends on the conformation of molecules that couple when they have complementary shapes, this one step physical process being equivalent with a longer algorithmic program with many steps). A fundamental difference would be if some form of quantum computation intervenes, but until now it was not demonstrated that a quantum computation could not be reduced to a Turing Machine. On the contrary, structural quantum computation may be reduced to a Turing Universal Machine. The only possibility of a difference, until contrarily demonstrated, is that in the process of self-organization of the structure of an organism some structural- phenomenological processes might trigger these changes. This is not impossible in the general structural-phenomeno-ogical frame of any living object.

Concerning the biological evolution, the part played by self-organization may indeed be very important under both frames. There are times for structural evolution and times for structural-phenomenological evolution. The biological evolution is a process of self-organzation of life, under both frames of this process.

The process of self-organization in the deep underlying reality depends on the phenomenological information (active information) and therefore may be seen as a phenomenological self-programming. This is consistent with the previous image (DRÃGÃNESCU 1985) of the self-generation of phenomenological senses. The birth of a universe may be the result of a process of phenomenological self-programming and the universe becomes a process of self-organization.

The drive for self-programming is given at this level by the tendencies of becoming (DRÃGÃNESCU 1991 a, 1996, DRÃGÃNESCU, KAFATOS 1998) which are also phenomenological senses. Tendencies of becoming (that may be seen as phenomenological laws) are the specific frame for the process of self-programming and self-organization in deepest reality.
The same type of processes may produce the self-organization of a Fundamental Consciousness (DRÃGÃNESCU 1998 d) around a fundamental infraconsciousness, which is a phenomenological sense of existing that assures the unity of the entire existence.

The Fundamental Consciousness might play a role in the manifestations of existence by generating phenomenological information and structures (universes) that express Its thinking, either for meditative thought which uses the former processes of self-organization in a specific frame established by this Consciousness.

Because infraconsciousness is given in the nature of existence, the Fundamental Consciousness is considered as a foundational principle (DRÃGÃNESCU, KAFATOS 1998).

Guided self-organization.

As mentioned, self-organization manifests at all levels of existence. Organization may be done by some form of intelligence (fundamental, natural, artificial, or a team of them or a part of them) in a detailed manner or only to establish the necessary specific frame for self-organization, which may fulfill the given tendencies or the followed objectives.

Self-organization is also present in the social life, much more that it was thought before. Many times self-organization may prove to be more beneficial than organization. Sometimes it is better to organize a frame for a somewhat guided self-organization. This is also true for the newest technol-ogies in the domain of neural networks, nanotechnologies, molecular electronics, in processes of self-replication etc. In the field of molecular electronics, which is a part of the domain of nanotechnology, an important progress (REED, TOUR 2000) has been made in obtaining self-assembly of atoms, molecules or group of molecules, in a spontaneous way into ordered patterns without intervention from outside. The combination of organization that creates regions for self-assembly of molecules among organized regions may generate complex structures of molecular computers. Self-assembly will be used with organized fabrication methods. Self-assembly is a form of self-organization in the structural domain. But "the first successful demonstration of self-assembly in molecular electronics occurred just four years ago, in 1996, when Paul S. Weiss's group at Pennsylvania State University tested self-assembled molecules" (REED, TOUR 2000, p.73). Already there are diodes, switches and memory cells with molecules at nanometric scale. There is not yet an equivalent of the transistor. At this scale new principles will emerge for the computer design, but self-assembly will be an essential part of these. It may be seen that self-organization will increase in importance for science, technology and philosophy.

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