TOWARD AN INTEGRATIVE SCIENCE

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ABSTRACT

We examine the need for a new approach to science that takes into account both structural science, i.e. current science as practiced by most scientists, and structural-phenomenological science, which allows for the coupling of quan-tum theory to brain functions, examines the nature of consciousness, etc. This new approach will result in what is termed integrative science and, we postulate, is the only hope to understand the nature of life, mind and consciousness. Integrative science will allow for both qualitative (e.g. qualia) and quantitative (e.g. a generalized mathematical formalism for consciousness based on category theory) aspects and bridge what appears at present to be a vast chasm separating physical theories from mind theories.

INTRODUCTION

The name of integrative science was given by Kafatos (2000 a) for a science that takes into account both structural and phenomenological aspects of reality (n1). Drãgãnescu (1990, 1993, 1995a) proposed a structural-phenomenological science, as an extension of the structural science of today that needs to be developed in order to explain life, mind, consciousness, and the quantum nature of the universe. Drãgãnescu and Kafatos (1999) proposed a set of foundational principles that cover structural, phenomenological as well as structural-phenomenological realms of science. Struppa et al. (2000), considered these principles to be compatible with a mathematical modeling of consciousness based on the theory of categories.

In this paper we examine the problem of consciousness as the last great frontier of science, the structural and phenomenological realms of reality, the principles that governs the structural science, and why the structural science has followed its own transformation into an integrative science.

REALMS OF SCIENCE

The heart of the structural science of today is the Standard Theory (or Standard Model) of particle physics, which is based on a 'renormalizable' quantum field theory having as sources quantum mechanics and special rela-tivity. The extremely successful Standard Theory, because of the exceptional experimental confirmations, describes the structure of the matter down to 10^{-20} cm. It succeeded to unify three of the four known fundamental forces: the strong force with the electroweak force, the last one being a unification of the electromagnetic force with the weak force. But it did not succeed to unify the above forces with gravitation:

> "The difficulty is that the Standard Model is a fully quantum mechanical theory, whereas general relativity is not quantum mechanical, and its predictions must therefore breakdown at very small scales [...]. The absence of a quantum-mechanical description of gravity renders the Standard Model logically incomplete" (Smith, 2000).
> "It seemed impossible, for fundamental reasons, to formulate a renormalizable quantum field theory of gravitation" (Weinberg, 1999).

Other flaws of the Standard Model: 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 (which received empirical values) and does not explain gravity (Kaku, 1994), and this model has no mechanism to account for the masses of elementary particles:

> "The Standard Model has no mechanism that would account for any of these masses, unless we supplement it by adding additional fields, of a type known as scalar fields. [...] The interaction of the other fields of the Standard Model with the all-pervasive scalar fields is believed to give the particles of the Standard Model their masses (n2). To complete the Standard Model, we need to confirm the existence of these scalar fields and find out how many types they are. This is a matter of dis-covering new elementary particles, often called Higgs particles, that can be recognized as the quanta of these fields. We have every reason to expect that this task will be accomplished before 2020, when the accelerator called the Large Hadron Collider at CERN, the European laboratory of particle physics near Geneva, will have been operating for over a decade" (Weinberg, 1999).

The problem of the mechanism that generates the observed masses of particles is an important one:

"Physicists believe that particle masses are generated by interactions with a field that permeates the entire universe; the stronger the particle interacts with the field, the more massive it is. The nature of this field, however, remains unknown. It could be a new elementary field, known as the Higgs field...." (Smith, 2000).

It is known that the Standard Model does not allow the neutrinos to have mass. Today there is some experimental evidence (Kearns, Kajita, Totsuka, 1999) of the mass of neutrinos, perhaps 10^{-2} eV (n3). It is also known that also the photon in specified conditions may have a non-zero rest mass (Vigier's theory) - see Amoroso, Kafatos, Ecimovic, 1998.

Steven Weinberg considers that "Observation of this kind will yield valuable clues to the unified theory of all forces, but the discovery of this theory will probably not be possible without radically new ideas" (Weinberg, 1999).

The second scaffold of the quantum physics, but still in the frame of the structural science, began with the development of supersymmetry theories (that can accommodate gravity) and string theories that could combine quantum mechanics and general relativity (requiring then supesymmetry).

The theories of supersymmetry and supergravity were developed for unifying the fundamental forces and explaining theoretically the Standard Model and are using a space-time with 11 dimensions (hyperspace) - 10-space dimensions and 1 time dimension. These theories lead to the concept of strings, superstrings (the incorporation of supersymmetry into string theory) and p-branes (Kaku 1994, Schwartz 1998, Duff 1998, Green B. (2000 a, 2000 b), Drãgãnescu 1998 b). 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.

The particles of the standard theory are vibration modes of the super-strings 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 B. 2000 a, b). 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 phenomenological.

The most advanced form of these theories is the M-theory (membrane theory). Steven Weinberg, who wrote recently a book on supersymmetry (Weinberg, 2000) observes:

> "But no one knows how to write down the equations of this theory [...] The development of the Standard Model was guided by a principle known as gauge symmetry, a generalization of the well-known property of electricity that it is only the difference of voltages that matter, not voltages themselves.
> But we have not discovered any fundamental principle that governs M-theory. The various approximations to this theory looks like string and or field theories in space times of different dimensionalities (n4) , but it seems probable that the fundamental theory is not to be formulated in space-time at all. Quantum field theory is powerfully constrained by principles concerning the nature of four-dimensional space-time that are incorporated in the special theory of relativity. How can we get the ideas we need to formulate a truly fundamental theory, when this theory is to describe a realm where all intuitions de-rived from life in space-time become inapplicable?" (Weinberg, 1999).

The non-locality of quantum processes in the universe is a strong argument for an underlying deep reality out of space and time (Kafatos, Nadeau, 1990, 1999, Kafatos 1998, Kafatos 1999):

> "Quantum theory states that whatever is meant by the word reality, it has to be non-local and counter to the view of local, realistic classical theories. The experimental evidence is revealed by the Aspect and Gisin experiments [...] and imply a non-local, undivided reality which reveals itself in the physical universe through non-local correlations and which can be studied through complementary constructs or views of the universe. Quantum theory and its implications open, therefore, the door for the thesis that the universe itself may be conscious (although this statement cannot be proven by the usual scientific method which separates object from subject or the observed from the observer)" - Kafatos (1999).

It is evident that the structural science has arrived at the frontier of a deep reality, which is outside of space and time (Drãgãnescu, 1979, 1985), and has opened the doors of a realm of reality in which phenomenological processes become predominant. This level of reality is the source of all that is phenomenological, and also is the source of the deep energy used and formed by phenomenological information into strings, membranes or elementary particles.

The structural science that remained purely structural (with its prequantum or classical domain, then with the quantum domain of the Standard Theory and followed with the quantum domain of Supersymmetry and Strings) until it reached the frontiers of deep reality, will be transformed entirely into a structural-phenomenological science because of a gnoseological wave, produced by some knowledge of deep reality. The phenomenological is always present in all reality of the universe either in a closed or an intro-open way.

When it is *closed* (the structural is hiding the phenomenological), in a very good first approximation, the reality may be treated as structural, but in a second approximation the phenomenological has to be taken into account. The classical physics, in a second approximation will admit phenomenological processes, because these are always present in the substrate of all things in a holistic way.

When it is *intro-open* (the phenomenological is directly available through the structural), the structural approximation is not anymore possible, and this, we believe, is the case for trying to understand mind and conscious-ness.

In general, structural science may be seen only as a first approximation to the more general structural-phenomenological science.

THE LAST FRONTIER OF SCIENCE

The scientific explanation of the brain/mind/consciousness reality is considered by Rose (1999) to be the last frontier of science:

> "The vast sweep of advances in biological knowledge of the past half cen-tury has made the brain, and its ambiguous relationship to mind, science's last frontier".

Ishikawa (2000) considers that

> "Most 'principles of life' that comprise exquisite functions of living bodies and brains are yet to be fully understood, and are believed to underlie diverse features unique to living organisms [...]. [The] exploration of information processing mechanisms that underlie the brain and other nervous systems, [is] a theme often referred to as the last frontier of mankind".

Moreover, the organisers of the Tucson IV (2000) Conference 'Toward a Science of Consciousness' consider the problem of consciousness as the last great frontier of science.

Drãgãnescu (2000 a, 1999) considered that both the quantum physics and the science of mind and consciousness are going together toward a unique frontier of science because the problem of the phenomenological information unifies the two frontiers of the quantum world and of consciousness into one. Quantum physics has involved into this unique frontier because mind and consciousness processes could find here a source of explanation.

Indeed, the greatest problems of today's science are related to consciousness.

Concerning consciousness, perhaps the most important forms to be taken into consideration are the following:

- *natural human consciousness* (related to mind and life);

- *artificial, supposedly human-like consciousness* (to be, eventually, obtained if some structures of hardware develop quantum phenomena similar with those of the human mind - Amoroso (1997 a, 2000), Goertzel (1998));

- *Fundamental Consciousness* of existence -Kafatos, Nadeau (1990, 1999), Drãgãnescu (1998 a, 1999).

If human consciousness cannot be essentially explained without quantum physics, *the corollary* *is that quantum physics cannot be further developed without taking into account consciousness processes.*

Because natural consciousness appears only in biological organisms, it is naturally to think that life used an extra-ingredient not known in structural science, as it is the phenomenological sense manifested as 'experience' or qualia. Therefore, every organism might have mental processes, even if not complete minds (Drãgãnescu, 1997 a). Allman (1999) mentions that even single-celled organisms such as bacteria have brainlike functions that enable them to find food and avoid toxins, and traces the development of brains from small and simple (like that of Escherichia coli) to large and complex.

Perhaps the most fundamental mental property of an organism is the feeling ('experience') of the unity of its body, which is much more than the unity brought by the feedback interconnections of its structures (Drãgãnescu, 1985) (n5) . The connection with quantum physics in the frontier of explaining life was considered essential:

> "The molecular biology will clarify the mystery of life by deepening quantum processes down to primary ingredients of matter. Just the access to one of these ingredients confers to the organism the character of unity and body, respectively by phenomena of specific quantum nature (by quantum intro-openness) which ensures access to informatter"(Drãgãnescu, 1985) (n6) .

The study of consciousness will, in turn, contribute to a complete understanding of life.

All the great problems of contemporary science are related to the phenomena of mind and consciousness:

- understanding the foundations of quantum physics;
- the explanation of biological evolution and life in general;
- the existence of intelligent robots and the possibility of conscious robots;
- the cosmology of the universe and the sense that it, perhaps, is related to the Fundamental Consciousness;

- the underlying deep reality as a basis for the Fundamental Consciousness and as a source for minds and consciousness in the universe.

EXPERIENCE, QUALIA, AND PHENOMENOLOGICAL SENSES

The first problem of contemporary science is the recognition or not-recognition of the phenomenon of 'experience' (or qualia) in the mental processes. If this problem is recognized, a number of possible consequences follow: a) 'experience' is manifested by all forms of life, beginning, at least with single and isolated cells; b) for 'experience', an extra-ingredient of nature, besides those of the structural science of today, is necessary to take part in the living and mental processes; c) 'experience' is the experience in a phenomenological sense (or a group of phenomenological senses), which is a natural property of the extra-ingredient mentioned above.

Classical physics was not able to explain experience. The only possibility for a connection to the physical world arose in quantum physics. That is why most of the physicists who deal with the problem of consciousness try to find the sources of consciousness in quantum phenomena of the brain (n7).

Concerning the main classes of structural and structural-phen-omenological theories of mind and consciousness, these theories may be (Drãgãnescu 1999 b): a1) structural theories for which the phenomenal experience is subjective (in fact it is neglected); a2) structural theories that recognize the phenomenal experience as real but some how assume that it is produced by informational *structures* (in unexplainable ways); a3) structural theories that recognize the phenomenal experience as real and being produced by *quantum structural* processes in the brain.

If one accepts the principle that the structural science (based on particles, fields, structures and, neglecting phenomenal experience as a genuine physical phenomenon) is incomplete and insufficient to explain life, mind, matter and, in general, the world (Drãgãnescu 1993; Drãgãnescu, Kafatos 1999), then all structural theories should be eliminated from the competition (n8).

The structural-phenomenological theories consider the phenomenal experience as a fundamental phenomenon, which cannot be explained by contemporary physics, either classical or quantum. These theories may be: b1) dualistic, considering that the phenomenal experience is transcendental; b2) intrinsic, considering that the phenomenological properties are inherent in the nature of quantum phenomena, for instance, at the level of the quantum wave function; b3) extrinsic, considering that an extra-ingredient, outside all the physical ingredients known today, is necessary for explaining phenomenal experience.

As such, the competition applies to structural-phenomenological theories, but these theories still have a structural part; and consequently structural aspects, explained in the frame of structural theories, remain relevant with regards to important components of a structural-phenomenological theory.

Dualistic theories (b1) cannot be retained in modern-day science. Such theories are showing that important aspects of mind and consciousness cannot be explained by contemporary science. Some structural-phenomenological theories consider that quantum processes in the brain inherently involve 'experience' phenomena, whereas others propose a quantum physics rooted in the deepest layer of existence where the source (the extra-ingredient) of the phenomenological senses may be found (n9).

The existence of such a deep source was proposed many years ago by Bohm (1980, 1985) - see also Bohm & Hiley (1993), Peat (1999) - and Drãgãnescu (1979, 1985). David Bohm named 'active information' the deep information, considered by him not to be of the digital form, but related to the nature of senses. Today, a great number of scientists from domains like physics, chemistry and information science are recognizing not only mental 'experience' as a scientific truth, but they consider that such a manifestation is a general phenomenon of existence.

Cairns-Smith (1999), classifies qualia (qualitative phenomena) as

- *raw perceptual sensations* (colour 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...),
- *background qualia* (moods, attitudes...).

To these we add the mental senses of concepts, ideas, feelings, and intuitions in every mental scientific activity.

Observing that the most significant aspect of qualia is precisely that the sciences of physics and chemistry have no explanation for them, Cairns-Smith considers that qualia is a bomb in the foundations of science, whereas qualia are a part of the physical world and science ought to be able to deal with them. He thinks that 'feelings and sensations are yet another way of arranging the quantum energy'.

What is phenomenological? Stapp (1993) defines phenomenology as the domain that investigates experience, which is indeed a more convenient modern interpretation. Phenomenology might be still better defined, adding to Stapp's definition, the study of phenomenological senses, in general: *Phenomenology is the domain of investigation, knowledge and practice of experience and phenomenological senses, in general* (Drãgãnescu 2000 a).

Related to humans, the phenomenological is the experiential and qualia. It may be seen, in general, as 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. This is a phenomenological sense or an informaterial sense. *In their 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 con-sciousness.

The difficulty of recognizing the phenomenological sense originates in the way the structural science was conceived and used.

At the question "What is structural?", the previous answer was too sim-ple to assert that it merely concerns particles, fields and structures. The structural may be better understood in the frame of a larger vision that comprises also the phenomenological (Drãgãnescu 2000 a):

> "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 (n10).
> 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 organization 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".

Seeing the structural science as the science practiced today, that was extended in this century from the physical realms to the informational domains (structural information of the genome (ADN), structural neurobiology, artificial intelligence, artificial life, molecular computing, quantum computing, etc.), Kafatos (2000 a) expressed the

> "need of phenomenological approaches to understand the vast realm of experiential, mental components of human and *universal experience"*.

Kafatos (2000 a) defined four levels of reality corresponding to four states of human experience:

- structural to waking state/physical
- structural-phenomenological to dream state
- phenomenological to deep sleep state/causal

- deep reality to supracausal

It is the last level that is the ground of all, where deep reality of the uni-verse becomes identical to deep (inner) reality of being.

The universal 'experience' mentioned above is related to the Fundamental Consciousness of Existence which was postulated as a foundational principle - Kafatos (2000 b, 1999), Drãgãnescu (1998 a, 1999 a), Drãgãnescu, Kafatos (1999), Kafatos, Nadeau (1990, 1999). The phenomenological part of reality is as important as the structural part, if not more important.

THE COMPETITION OF TWO PRINCIPLES

There are two contrary principles today that are haunting the commu-nity of scientists:

> *A) The structural science is sufficient to explain all nature, y compris, life, mind and consciousness.*
>
> *B) The structural science is not sufficient, and is incomplete for explaining all existence, y compris, life, mind and consciousness.*

The inertia of the structural science is very great, and many scientists are declaring in an open way that they believe firmly in principle A. They hope, for instance, that the living cell or the brain will be completely modeled in the frame of the structural science on digital computers, because physical law is amenable to computer simulation and biological structures are derived from physical law.

The authors of this paper are on the side of principle B, without minimizing the importance of structural science, or of the structural part of a structural-phenomenological science. The principle B is a foundational principle for an integrative science.
For the structural realms of science and reality, because any structural information processing is submitted to the Turing-Church thesis, any computation can be realized by a structural physical process, and any structural physical process is equivalent with a computation. If principle A were sound, then computer modelling of the biological cell and even of mind and consciousness would be possible. Moravec (1999) considers that only greater and greater computer power will lead to human level capabilities, with the same kind of perception, cognition and thoughts as humans. He advocates principle A recognizing that

> *"This issue is controversial in some circles right now, and there is room for brilliant people to disagree,"*

and further,

> "(If) the assumption is wrong, we will someday find specific animal or human skills that elude implementation in robots even after they have enough computer power to match the whole brain. That would set the stage for a fascinating scientific challenge - to somehow isolate and identify the fundamental ability that brains have and that comput-ers lack. But there is no evidence yet for such a missing principle."

If Moravec accepts the possibility of infringement of principle A, because the rumour about non-missing principles like those of phenomenological ingredients and processes is growing, he would like a demonstration of these with the methodology of the structural science, otherwise they do not exist.

There exists, for instance, a non-computational information processing. Penrose (1994) demonstrated its existence by studying the functioning of the human brain, mind and consciousness. It was also shown the brain is capable of a non-formal information processing (Drãgãnescu 1985), which is a non-computational information processing, and that any structural-phenomenological or phenomenological physical process is equivalent with a non-formal information processing (Drãgãnescu 1997 b). Phenomenological information is implied in such processes. Any non-computational information processing cannot be strictly structural, it always implies phenomenological processes.

Principle B advocates the need for new ingredients, new principles and a new physics namely, a structural-phenomenological physics.

We predict that science will renounce principle A for principle B due primarily to the difficulties encountered in the explanation of mind and consciousness. Because the phenomenological behaviour of the mind involves quantum physics, it is natural to think that some forms of quantum computers will be capable of involving the phenomenological components of quantum phenomena. In such a case, artificial conscious quantum computers could be built. Green H.S. (2000) (n11) considers that 'the development of quantal computer programs with the basic requirements of self reproduction and artificial consciousness' will be the next step in the process of evolution. Further he writes:

> "Already a symbiotic relationship has developed, between human beings and a computer network extending throughout most of the world and able to transfer and process information with superhuman speed and efficiency. The introduction of nodes of artificial consciousness into this network, operating on qubits instead of the bits of the classical Turing machine, could lead to the development of an ecological system with the best qualities evolved by natural selection and with an immeasurably greater intelligence and wisdom than is at present evident in human affairs".

The problem of consciousness leads, therefore, not only to the last frontier, mostly unexplored, of science, but also to perhaps the most important frontier for mankind in the 21st century.

THE INTEGRATIVE SCIENCE

Because a universe is born from the deep reality, the structural-phenomenological science of the universe comprises a part of the knowledge of the processes of this ultimate reality. It seems that for the deep reality, y compris for the Fundamental Consciousness, the structural-phenomenological science is what is to be expected. But even if we may know the dynamics of phenomenological senses, their play in the deep reality, and their coupling with the orthoenergy (deep energy), still the intrinsic nature of phenomenological senses and their primordial properties remain a mystery. We do not know if their nature and primordial properties could be known by science, as we understand it today. Perhaps other forms of knowledge will be necessary, and if these would be accepted one day by science, then we shall have a *complete integrative science*. Until then, the structural- phenomenological science will be the integrative science that will also deal with most of the phenomenological processes. It can address deep reality even if not completely (it may use some philosophical suppositions).

The need for integrative science will bring new ways of doing science (Kafatos 2000 a),

- Based on foundational principles that cut across different levels;
- Able to address the phenomenological realms;
- Starting from the whole to study the parts;
- To find connections from all fields of human experience (e.g. perennial philosophies, metaphysics, etc.) to explore and enlarge scientific frontiers (as expressed in foundational princi-ples);
- Returning to structural approaches to make concrete suggestions for new theories, which are based on phenomenological realms but in turn provide structural solutions.
- Prescribing general approaches from where current structural theories can be derived (e.g. category theory of mathematics as the common underlying language of physical/mental/deep reality realms);
- It will not insist on separating object from subject.

The integrative science needs foundational principles as those elabo-rated by Drãgãnescu, Kafatos (1999), and a mathematical language like that of the Theory of Categories (Struppa, Kafatos, Roy, Kato, Amoroso, 2000) which seems to be best adapted for the structural-phenomenological processes of reality (Drãgãnescu 2000 b). The categories with their morphisms and functors will become also physical and informational realities, not only mathematical concepts.

For the theory of consciousness two main types of structural-phenomenological theories are possible (Drãgãnescu 2000 a): *envelope and detailed theories*.

Works for a detailed theory are in progress (n12) . The most advanced of them is the Noetic theory of Richard Amoroso (Amoroso 1997 b). Nevertheless, there are sufficient elements to build theories that envelop all the physical and informational details. Recognizing the 'experience' and the phenomenological sense as scientific facts, recognizing the coupling between the phenomenological and the structural as 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 of the generation of a universe, theories of life, mind and consciousness, even of a Fundamental Consciousness.

Both the above types of theories are parts of the integrative science.

For instance, what it is essential for the human mind and consciousness is the correspondence between the category of neuronic structures C_{str} and the category of phenomenological senses C_{phen}. This correspondence is assured by two functors, one structural-phenomenological F, and the other phenomenological-structural R . These functors are real physical and informational processes, and in each of these categories there are specific morphisms, structural in C_{str} and phenomenological in C_{phen}. These elements may be sufficient for an envelope theory.

For a detailed theory, other categories have to be taken into consideration between C_{str} and C_{phen}, like the layers of physical processes proposed by Jibu and Yassue (1995) and Amoroso (1997). Let us consider the layer, proposed by Amoroso, of the coherent quantum waves in the brain which are "connected" to phenomenological senses (having their source in the deep reality). The coherent quantum waves are forming a category that has structural functors, on the one side, in both directions with , and, on the other side, has functors, in both directions, with C_{phen}. (In another way, it may be said that the coherent quantum wave contains two own functors between its structural and phenomenological parts).

Hence, if for the *envelope theory*,

$$\mathbf{C_{str} \Leftrightarrow C_{phen}}$$

where <=> represents the two functors between these categories, then for the detailed theory, descriptions of the form

$$\mathbf{C_{str} \Leftrightarrow C_{coherent\ quantum\ waves} \Leftrightarrow C_{phen}}$$

are at least necessary, or perhaps, of the form

$$\mathbf{C_{str} \Leftrightarrow C_{1str} \Leftrightarrow \ldots \Leftrightarrow C_{kstr} \Leftrightarrow C_{coherent\ quantum\ waves} \Leftrightarrow C_{phen}}$$

In the above, $C_{1str,}$ C_{2str}, ... , C_{kstr} are structural categories of the brain, other than neuronic structures, but intermediary categories (dendritic networks, molecular vibrational fields along protein filaments, perimembraneous waves, quantum cortical fields - after Jibu and Yassue, 1995 (n13)) between C_{str} and $C_{coherent\ quantum\ waves}$.

It seems that we may think about the mathematics of the integrative science as being also an *integrative mathematics* of the structural and phenomenological processes in the nature. It will use perhaps notions like the usual (structural) categories, phenomenological categories, structural- phenomenological categories, functors, both structural-phenomenological and phenomenological- structural, all these being at the same time physical and informational phenomena and processes of reality.

NOTES

(n1) Experience, qualia and other manifestations of phenomenological senses.
(n2) It might be interesting to mention that in Drãgãnescu (1985, p.135-138) the mass of elementary
particles was not considered to be a direct effect of a phenomenological sense, as it is the case of charges (electrical, leptonic, baryonic, strangeness, charm, etc.), but a derived effect.
(n3) For comparison the mass of the electron is 5.11x 105 eV.
(n4) Various string theories (Kaku 1994) use 10, 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.
(n5) p.207-209.
(n6) p. 223-224. The extra-ingredient necessary for life, mind and generation of a universe was called informatter.
(n7) There are also exceptions. Mulhauser (1998) considers that classical physics is sufficient to explain 'experience'. For him, phenomenal experience is 'what is like to be' by changing the informational structure of a structural self-model as the seat of the conscious experience. Therefore, he recognises 'experience', but its nature remains not at all explained. In fact, his demonstration is a strong argument for the existence of an extra-ingredient (Drãgãnescu, 1999 b).
(n8) See the following section "The competition of two principles".
(n9) For some details concerning these theories see more in Drãgãnescu (1999 b).
(n10) Although aspects of it may be.
(n11) p. 209.
(n12) A presentation in Drãgãnescu (1999 b).
(n13) See also a presentation in Drãgãnescu (2000c).

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