

QUANTUM INFORMATION, SELF-ORGANIZATION AND CONSCIOUSNESS: A HOLOINFORMATIONAL MODEL OF CONSCIOUSNESS

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Abstract. The author proposes a holoinformational view of consciousness based on the holonomic theory of brain function and quantum brain dynamics developed by Karl Pribram, Sir John Eccles, Hameroff, Jibu and Yasue, and the quantum-holographic and holomovement theory of David Bohm. This conceptual framework is integrated with the non-local information property of the Quantum Field Theory of Umesawa, the concept of negentropy, order, and organization developed by Shannon, Wiener, Szilard and Brillouin, and the theories of self-organization and complexity of Prigogine, Atlan, and Jantsch. Wheeler's "it from bit" concept of a *participatory* universe, and the physics of information developed by Zurek and others with the concepts of statistical entropy and algorithmic entropy, related to the number of bits being processed in the mind of the observer, are also considered. This new synthesis gives a self-organizing, quantum-holographic, non-local informational basis for a transpersonal model of consciousness in a participatory universe. In this synthesis, consciousness is conceived as quantum non-local significant information interconnecting the brain and the cosmos by means of a holoinformational field, with a non-local/quantum holistic component interconnecting mind and cosmos, and a local/Newtonian mechanistic component interconnecting brain and mind. This non-local quantum-holographic cosmos manifests itself through a quantum-holographic transpersonal consciousness, interconnecting in a participatory holistic and indivisible way the human brain with all levels of the universe.

Keywords: *transpersonal psychology, holoinformation, consciousness, quantum-holographic information, non-locality, self-organization, integrative medicine.*

1. Introduction

*"The Tao obscures when we only see small
pieces of the universe"*
Chuang-Tzu

Models that try to explain the nature of awareness using the Cartesian-Newtonian paradigm insist on a reductionist view of consciousness. This reductionist view has been impairing the essence of consciousness since the seventeenth century. Hameroff [1] believes that such dispute "*may potentially be resolved by views which contend that consciousness has a distinct quality, but one which emerges from brain processes which can be accounted for by natural science*". As a solution he proposes a consciousness model based upon the emergence of quantum coherence in neural microtubules, which he developed with Penrose [2]. These models use a traditional interpretation of quantum mechanics, and as Clarke [3] shows, "*start from a basically quantum-mechanical position but then impose modifications of the quantum formalism so as to ensure that the net result is basically Newtonian ... Strong emphasis is placed on the wave function as the*

fundamental object of quantum theory and a “collapse” is invoked to pass to a Newtonian picture. As a result, they are very firmly bound to a spatial picture.” By transforming the quantum logic into a Newtonian logic they cut off non-locality, a fundamental property of the quantum field theory of the universe [4] and of consciousness. We will show that consciousness and information, like energy, matter and space must be seen as a fundamental property of the universe, providing a new understanding of the relationship between life and physical matter as we will see later based on Zureck [27], and Wheeler [12]. Wilber [5] considers that an integral theory of consciousness should embody all the essential characteristics of the main schools that study consciousness, *“not as an eclecticism but rather a tightly integrated approach that follows intrinsically from the holonic nature of the Cosmos”*. Such holonic nature of the Cosmos is based upon the self-organizing holoarchy described by Jantsch [6] that correlates the co-evolutionary interactions amongst the microevolution of the holons described by Koestler [7], to the macroevolution of its collective/social forms. Wilber’s theory, however, leaves open what we consider the key point in the understanding of consciousness, that is, the way by which information, (i.e. order, negentropy), is transmitted amongst the infinite levels of organization of the cosmic-brain holoarchy, giving meaning to them. This common ground capable of integrating consciousness and Cosmos in an ordered and indivisible whole can only be fulfilled by a holoinformational (Newtonian local information + quantum non-local information), model of consciousness that connects the universe’s non-local quantum-holographic informational structure with the brain’s non-local informational quantum-holographic fields and also with the classic local neural networks of the brain, as I have already described elsewhere [8-11]. Also this holoinformational model having Bohm’s quantum-holographic deterministic theory as one of its foundations is compatible with Einstein’s theory of relativity.

Wheeler [12] realized how important information is in such context. Wheeler proposes an elegant information-participatory Universe that is a brilliant and insightful model of brain-mind-Cosmos interaction. With his famous *“it from bit”* concept he unites quantum information theory to consciousness and physics: *“...every it - every particle, every field of force, even the space-time continuum itself - derives its function, its very existence, entirely - even if in some contexts, indirectly - from the apparatus-elicited answers to yes-or-no questions, binary choices, bits”*. *“It from bit symbolizes the idea that every item of the physical world has at bottom – at a very deep bottom, in most instances – an immaterial source and explanation; that which we call reality arises in the last analysis from the posing of yes-no question and the registering of equipment-evoked responses; in short, that all things physical are information-theoretic in origin and this is a participatory universe”*. In the same paper Wheeler gives the example of a photon being detected by a photodetector under watch, when we ask the yes-or-no question: *“Did the counter register a click during the specified second ? If yes, we often say “a photon did it”. We know perfectly well that the photon existed neither before the emission nor after the detection. However, we also have to recognize that any talk of the photon “existing” during the intermediate period is only a blown-up version of the raw fact, a count. The yes or no that is recorded constitutes an unsplitable bit of information”*.

2. Order, Information and Self-Organization

A wide idea of order, organization, information and negentropy that goes beyond the classical works of Wiener [13], Shannon [14], Szilard and Brillouin [15] is essential for the development of our holoinformational model capable of integrating consciousness to nature. Leon Brillouin, in his famous theorem, showed the equivalence between information and negentropy. Norbert Wiener put this identity on the very conceptual basis of cybernetics stating that *“information represents negative entropy”*, and prophetically for the first time in the history of science emphasizing that *“information is information, not matter or energy”*. Chalmers [16] states that information is an essential property of reality, as matter and energy, and that *“conscious experience must be considered a fundamental feature, irreducible to anything more basic”*. Bateson [17] defines information as *“the difference that makes a difference”*, a concept that Chalmers [18] retakes, stating that this is *“the natural way to make the connection between physical systems and informational states”*. The equivalence/identity between order, negentropy and information, is the way that allows us to build upon and understand the whole irreducible and natural flow of order transmission in the universe, organized in a meaningful and intelligent informational mode. In the classical thermodynamic theory, the definition of order is probabilistic and dependent on the entropy concept, which measures the degree of disorder of a system, reducing to uncertainty the immense dimension of natural meanings. For Atlan [19,20], as well as for Di Biase [21-23], *“entropy shouldn’t be understood as a disorder measure, but*

much more as a measure of complexity". In order to do this, it is necessary to consider that the notion of information implies a certain ambiguity, meaning the bit capacity of a physical system as Shannon put it, or the semantic content (meaning) conducted by the bits during a communication. In the information theory, the organization, the order expressed by the amount of information in the system (Shannon's H function) is the information measure that is missing for us, the uncertainty about the system. Relating this uncertainty, this ambiguity to the variety and the non-homogeneity of the system, Atlan could solve certain logical paradoxes of self-organization and complexity, widening Shannon's theory and defining organization in a quantitatively formal mode. Atlan showed that the system's order corresponds to a commitment between the maximum informational content (i.e. the maximum variety) and the maximum redundancy, and showed also that the ambiguity can be described as a noise function, or even a time one, if we consider the time effects as related to the random factors accumulated by the environment's action. Such ambiguity, peculiar to self-organizing systems, can be manifested in a negative way ("*destructive ambiguity*") with the classical meaning of disorganizing effect, or in a positive way ("*autonomy producer ambiguity*") that acts by increasing the relative autonomy of a part of the system in relation to the others, that is reducing the system's natural redundancy and increasing its informational content. Atlan developed this self-organizing theory of complexity for biological systems. Jantsch [5], studying the evolution of the universe, showed that cosmological evolution is also a self-organizing process, with the microevolution of the individual systems (holons) co-evolving towards macrosystemic collective structures better organized, with a big reduction in these collective systems. This whole self-organizing process is a universal expression of a bigger acquisition of variety or informational content that, as Atlan demonstrated, is a consequence of a reduction of redundancy in the totality of the system.

2. Information and Dissipative Structures

Ilya Prigogine [24,25], Nobel Prize winner, developed an extension of thermodynamics that shows how the second law can also allow the emergence of novel structures, and indicates the ways in which order can emerge from chaos. This type of self-organization generates dissipative structures that are created and maintained through the energy's exchanges with the environment in non-equilibrium conditions. These dissipative structures are dependent upon a new order, called by Prigogine "*order from fluctuations*", which corresponds to a "*giant fluctuation*" stabilized by the exchanges with the environment. In these self-organizing processes the structure is maintained through an energy-information dissipation that displaces itself, simultaneously generating (*in-formating*) the structure through a continuous process. The more complex the dissipative structure, the more information is needed to keep its interconnections, making it consequently more vulnerable to the internal fluctuations, which means a higher instability potential and higher reorganization possibilities. If fluctuations are small, the system adjusts to them and does not change its organizational structure. If the fluctuations reach a critical size, however, they cause disequilibrium in the system, generating new intra-systemic interactions and reorganization. "*The old patterns interact between themselves in new ways, and establish new connections. The parts reorganize themselves in a new whole. The system reaches a higher order*" [25].

3. Self-Organization and Information

Seager [26] states that consciousness, self-organization and information are connected at the level of semantic significance, not at the level of "bit capacity", and that "*as the classical theory of information is situated at the level of "bit capacity" it would seem unable to provide the proper connection to consciousness*"...and "*we can begin to move towards a more radical view of the fundamental nature of consciousness with a move towards a more radical view of information*". Seager still reminds us that in the famous two-slit experiment, and in the quantum eraser experiment, what is at stake is not the bit capacity, but the semantically significant correlation of *information laden* distinct physical systems, in a non-causal mode.

Chalmers [16] argues that each informational state has two different aspects, one as conscious experience, and the other as a physical process in the brain, that is, one internal/intentional and the other external/physical. This view finds support in the present developments of the so-called "information physics", developed by the physicist Wojciech Zurek [27] and others, which proposes that the physical entropy would be a combination of two magnitudes that compensate for each other: the observer's ignorance, measured by Shannon's statistical entropy, and the disorder degree of the observed system, measured by the

algorithmic entropy which is the smallest number of bits needed to register it in the memory. During the measurement, the observer's ignorance is decreased by the increase in bit numbers in its memory, leaving, however, constant the sum of these two magnitudes, that is, the physical entropy.

In this informational view of the universe, the observer remains included as part of the system, and the quantum universe changes because the observer's mind unleashed a transfer of information at a subatomic level. Also Stonier [28,29] identifies information with the structure and organization of the universe, arguing that information is the *cosmic organizational principle* with a "status" equal to matter and energy.

From this all it is possible to infer a *Law of Conservation of Information*, more fundamental than the law of conservation of energy. In this scientific emergent model of information, *in*-formation and in my conception also consciousness are the fundamental reality of nature, "the ground of all being", citing the Vedas.

In this holoinformational model, what self-organizes significantly the cosmic evolution is the relationship between the physical entropy and the universe's quantum-holographic informational content, through a process in which complexity uses the pre-existing informational content to reach higher organizational levels and variety. In this way, complexity in the universe grows gradually from gravity and atomic forces, intensifies with the emergence of self-organizing macromolecular systems of the biosphere, and reaches an almost infinite antientropic state of complexity, variety and informational content with the emergence of the noosphere and its quantum-holographic neural networks conscience. We will see that there is a quantum holographic physical theory of the universe that has implicit in its conceptual framework, besides the mechanistic local interactions, a non-local quantum informational unfolding, that self-organizes matter, life and consciousness in a meaningful way.

4. Transpersonal Consciousness

Consciousness studies based in thousands of psychotherapeutic experiences reported by contemporary medical and psychological consciousness researchers (Di Biase [30,31,32], Grof [33], Moody Jr. [34], Ring [35], Sabom [36], Kubler-Ross [37]), with subjects in altered states of consciousness such as hypnosis, relaxation, meditation, holotropic breathing, out-of-body experiences, prayer etc, surprisingly show "*an ontology and a cosmology in which consciousness cannot originate from, or be explained in terms of any other thing. It is a primordial factor of existence and from it emerges everything that exists*" (Grof, in Capra [38]). Presently, there are available a series of psychotechnologies that are usually ignored and/or marginalized by the academic community, which allow us to use the human mind as a reliable system of investigation and elucidation of the nature of consciousness. I also emphasize here the numerous philosophical psycho-spiritual systems that during the history of humanity have been exploring, through meditation and other psycho-technologies, the nature of consciousness, having described a vast and systematized *canon* of experiential knowledge and wisdom about consciousness (see for instance the interface between Buddhism and Neuroscience that is being studied by Western neuroscientists in collaboration with the Dalai Lama and buddhist monks at the Mind and Life Institute).

5. Nature, Information and Consciousness

We understand, as Weil [39], that "*intelligence's nature is nature's intelligence*" and like Atkins [40] that "*consciousness is emergent information itself at the moment of its generation, ongoing, self-organizing change in a self/world model*". It follows that only a holoinformational and self-organizing theory, capable of integrating intelligence and consciousness to the non-local quantum-informational tessitura of the universe, can solve the question of consciousness. Fortunately, there is a quantum theory of the universe that integrates consciousness as an irreducible dimension of nature in its framework. It is the quantum-holographic theory of the holomovement developed by David Bohm [41], that mathematically demonstrates the existence of a hidden, spectral, implicit order in the universe, a primary reality. Matter, life and consciousness (the explicate order), would originate from this common ground (the implicate order) by means of a continuous movement of unfolding and enfolding of the cosmos, called "holomovement". Bohm [42] states that "*in the implicate order everything is folded into everything. But it's important to note here that the whole universe, is in principle enfolded into each part actively through the holomovement, as well as the parts. Now this means that the dynamic activity - internal and external - which is fundamental for what each part is, is based on its enfolding of all the rest, including the whole universe. But of course, each part*

may unfold others in different degrees and ways. That is, they are not all enfolded equally in each part. But the basic principle of enfoldment in the whole, is not thereby denied. Therefore enfoldment is not merely superficial or passive but, I emphasize again, that each part is in a fundamental sense internally related in its basic activities to the whole and to all the other parts. The mechanistic idea of external relation as fundamental, is therefore denied. Of course such relationships are still considered to be real, but of secondary significance. That is, we can get approximations to a mechanistic behavior out of this. That is to say, the order of the world, as a structure of things that is basically external to each other, comes as secondary and emerges from the deeper implicate order". We live in a quantum-holographic universe in which reality is essentially non-local, and the classical Newtonian world with its external local interactions, emerges as a special case from this deeper quantum order. According to Bohm [43], the analogy with the hologram in which each part of the system is an image of the total object, even if it is a static image that does not transmit the dynamic nature of the infinite unfolding and enfolding which at each moment create our universe, is a functional metaphor, because "the mathematical laws of the quantum theory that apply to these waves, and therefore to all matter, can be seen to describe just such a movement in which there is a continual enfoldment of the whole into each region, along with the unfoldment of each region into the whole again. Although this may take many particular forms - some known, and others not yet known - this movement is universal as far as we know" [43]. This universal movement of enfoldment and unfoldment is Bohm's "holomovement". In a posterior development, Bohm [44] postulated the existence of a superimplicate order, a still more subtle dimension of the universe's organization. In this model, a quantum superinformation field of the totality of the universe would organize the implicate first level in multiple wave-like structures which would unfold in the explicate order. According to Bohm [see Weber, 45] "there is a physical model developed by De Broglie that proposes a new type of field, which activity is dependent upon the information content that is conducted to the whole experimental field, which, if extended to the quantum mechanics, results in the superimplicate order". This De Broglie-Bohm information field is the non-local informational field that can interact with the brain's non-local quantum-holographic fields. As we will see latter, these non-local fields can, through quantum coherence and superradiance in microtubules and synapses, and through Bose-Einstein condensates and Fröhlich effect in water and molecules of protein in the CSF and neurons, generate local fields in brain's neural network. This is the very basis of our holoinformational model: quantum-holographic non-local informational field interacting with the local "classic" neural networks.

6. Consciousness and Non-Locality

Bohm [44] developed a model in which the Quantum Potential (satisfying Schrödinger's equation, but depending on the form, not on the amplitude of the wave function) conducts "active information" that "guides" the particle along its way. The quantum potential is different from other forces of nature and does not decay with distance. This allows communication between this "pilot wave" and the particle, more rapidly than the speed of light, in a non-local mode [42, 44] fundamental in the holoinformational view of consciousness. In 1982, Alain Aspect et al. experimentally proved the existence of non-locality; more recently, in July 1997, Nicolas Gisin et al.[46] proved the non-local instantaneous quantum action between two locations separated by almost 30 km in Switzerland.

In contrast to Bohr's orthodox theory, in David Bohm's quantum holographic theory, elementary particles do not have a dual wave/particle nature but are particles all the time, and not only when observed. Actually, the particle originates from a global quantum field fluctuation, and it is determined by the quantum potential "that carries information about the environment of the quantum particle and thus informs and affects its motion. Since the information in the potential is very detailed, the resulting trajectory is so extremely complex that it appears chaotic or indeterminist", as Peat states [47]. Attempts to measure a particle's properties changes the quantum potential, destroying its information. Actually, according to Bohm, Niels Bohr had interpreted the uncertainty principle as meaning "not that there is uncertainty, but that there is an inherent ambiguity" in a quantum system [see Horgan, 48]. As John Bell [49] observed, "the De Broglie-Bohm's idea seems... so natural and simple, to resolve the wave-particle dilemma in such a clear and ordinary way, that it is a great mystery... that it was so generally ignored".

In the quantum-holographic theory, as Bohm [45] put it, "no field organized the implicate order, and it was consequently linear and difficult to unfold. The implicate order is a wave function, and the superimplicate order or superior informational field, is a function of the wave function, i.e. a superwave function that makes the implicate order non-linear organizing it in complex and relatively stable structures.

Besides that, the holographic model as a way of organization of the implicate order was dependent upon the quantum informational potential field, that did not have capacity for self-organization and transmission of the information, essential for the understanding of the genesis and development of matter, life and consciousness. The superimplicate order fills this need, allowing the understanding of consciousness, energy and matter as expression varieties of a same informational order. As a result consciousness would already have been present since the beginning of creation in the various levels of nature's unfolding and enfolding".

"Even a stone is in some way alive" states Bohm.

7. Towards a Holoinformational Model of Transpersonal Consciousness

The quantum potential guides by means of active information the particle alongside its course. As any elementary particle is united to the whole cosmos by means of a non-local quantum potential, information then starts to be understood as nature's fundamental process. This active non-local information that organizes the whole universe shows us that nature is informationally meaningful. In the brain, this means that informational processes are part non-local and part local i.e. holoinformational. To understand this holoinformational nature of consciousness and intelligence in the universe allows us to understand matter, life and consciousness as meaningful activities, intelligent quantum-informational processes, order transmitted through the cosmic evolution, originated from a generating informational field beyond our perception limits. A universe full of quantum potential and significant informational activity is an intelligent universe *functioning like a mind*, as Sir James Jeans already had observed. So, consciousness is always present in all levels of organization of nature, and matter, life and consciousness cannot be considered as separated entities, capable of being analyzed under a fragmentary Cartesian-Newtonian framework - but must be considered as an indivisible unity, with quantum informational processes interacting by means of non-local holistic relationships, and simultaneously by local Newtonian mechanistic relationships, generating self-organization, complexity, intelligence and evolution. Such view of a holoinformational intelligent "continuum", a fundamental generating order with a quantum-holographic informational creative flow permeating the whole cosmos, permits to understand the basic nature of the universe as an intelligent self-organizing unbroken wholeness, i.e. a universal consciousness unfolding in an infinite holoarchy. As a quantum-holographic system this universal consciousness is distributed in every part of the Cosmos, and each part of this holosphere contains the information of the whole cosmos in a holistic indivisible way. Quantum-informational fluctuations generated from this universal consciousness through the holomovement (a non-local holoflux) self-organize the universe's basic informational levels:

- The *Cosmosphere* with the *Atomic-Nuclear Code* that organizes energy and matter. It is the physical level and information is stored in atomic structures.

- The *Biosphere* with the *Genetic Code* that organizes life. It is the biological level and information is stored in the DNA molecules.

- The *Noosphere* with the *Neural Code* that organizes the brain and mind. It is the psycho-social level and information is stored in neural networks

- The *Technosphere* with *Artificial Intelligence Codes*. It is the technology level and information is stored in the internet, in hardware and software designs

- The *Consciousphere* with the *Quantum-Holographic Code*. It is the consciousness level that organizes the interconnectivity between the mind and the universe. It is the spiritual level, and information is stored in quantum-holographic networks of the brain and the cosmos. Such informational codes, this order that is transmitted in a meaningful and intelligent way through all levels of complexity of the universe, is the negentropic self-organizing nature of information-consciousness, an irreducible physical dimension of the cosmos as energy and matter.

This religation (latin *religare* and english *religion*) between us and the universe connects us with our primordial source, and has been described in a symbolic way in spiritual philosophy by metaphors like "*the father is within us*"; "*as above so below*"; "*as in earth so in heavens*", or the beautiful buddhist metaphor of

Indra's net : *"Far away in the heavenly abode of the great god Indra, there is a wonderful net that has been hung by some cunning artificer in such a manner that it stretches out infinitely in all directions. In accordance with the extravagant tastes of deities, the artificer has hung a single glittering jewel in each "eye" of the net, and since the net itself is infinite in all dimensions, the jewels are infinite in number. There hang the jewels, glittering like stars of the first magnitude, a wonderful sight to behold. If we now arbitrarily select one of these jewels for inspection and look closely at it, we will discover that in its polished surface there are reflected all the other jewels in the net, infinite in number. Not only that, but each of the jewels reflected in this one jewel is also reflecting all the other jewels, so that there is an infinite reflecting process occurring [50]. According to Cook Indra's Net "symbolizes a cosmos in which there is an infinitely repeated interrelationship among all the members of the cosmos. The totality of the Cosmos is seen as a vast body of members each sustaining and defining all the others, the cosmos is, in short, a self-creating, self-maintaining, and self-defining organism... There is no theory of a beginning time, no concept of a creator, no question of the purpose of it all. The universe is taken as a given. There is no center, or, perhaps if there is one, it is everywhere."*[50]

8. Quantum Brain Dynamics

Experimental studies developed by Pribram and other consciousness researchers like Hameroff [1] and Penrose [2], Jibu and Yassue [51] confirm the existence of a Quantum Brain Dynamics in neural microtubules, in synapses and in the molecular organization of the cerebrospinal fluid. This Quantum Brain Dynamics can generate Bose-Einstein condensates and the Fröhlich effect. Bose-Einstein condensates consist of atomic particles, or in the case of the Fröhlich effect, of biological molecules, that can assume a high level of coherent alignment, functioning as a highly ordered and unified informational state, as seen in lasers and superconductivity. Psychons were only defined by Eccles' in a philosophical manner restricted to the interaction operating on synapses by way of quantum coherence processes. Here I am extending his idea to the whole of quantum and holographic states in the brain and cosmos as described by Pribram in the cortex, by Penrose and Hammeroff in microtubules and by Fröhlich effects in macromolecules, and Bose-Einstein condensates in the quantum structure of the cerebro-spinal fluid, and by Bohm non-local quantum potential in the whole quantum-holographic universe. I see all this interconnections as a holoflux connecting brain and cosmos. These quantum dynamics show us that the interaction process between dendrons and psychons are not limited to the synaptic cleft, as stated by Eccles, but have a much wider embodiment throughout the whole brain, and as some researchers (see Popp), are saying, also throughout the whole body. Ho [52] has shown that *"highly polarized multiple layers of liquid crystalline water molecules form dynamically coherent units with the macromolecules, enabling them to function as quantum molecular energy machines that transform and transfer energy with close to 100 percent efficiency. This liquid crystalline continuum of intimately associated polarized water and macromolecules extends throughout the extracellular matrix into the interior of every single cell, enabling each cell, ultimately each molecule, to intercommunicate with every other"*. Pribram [53,54] shows good evidence that Eccles' dendrons make receptive fields in cortical sensory units. Dendrons are composed of pre-synaptic teledendrons, synapses and post-synaptic dendrites, and they compose the fine fiber structure wherein brain processing occurs. As Pribram states [55], *"as sensory generated receptive fields they can be mapped in terms of wavelets, or wavelet-like patterns such as Gabor Elementary Functions. Dennis Gabor (1946) called these units Quanta of Information. The reason for this name is that Gabor used the same mathematics to describe his units as had Heisenberg in describing the units of quantum microphysics. Here they define the unit structure of processes occurring in the material brain"*. I see these quantum holographic interactions as a natural extension of Eccles' ideas [9] of an interactionism between dendrons and psychons [56-61].

Rakovic [62] points out how *Quantum-Holographic and Classically-Reduced Neural Networks can model psychosomatic functions: "The prevailing scientific paradigm considers information processing within the central nervous system as occurring through hierarchically organized and interconnected neural networks. However, it seems that this hierarchy of biological neural networks is going down sub-cellular cytoskeleton level, being according to some scientists a kind of interface between neural and quantum levels. At the same time it appeared, within the Feynman propagator version of the Schrödinger equation, that the quantum level is described by analogous mathematical formalism as Hopfield-like quantum-holographic associative neural network. The mentioned analogy opens additional fundamental question as to how the quantum parallel processing level gives rise to classical parallel processing level, which is a general*

problem of the relationship between quantum and classical levels within the quantum decoherence theory as well. The same question is closely related to the fundamental nature of consciousness, whose in-deterministic manifestations of free will and other holistic manifestations of consciousness like transitional states of consciousness, altered states of consciousness, and consciousness pervading body – necessarily imply that some manifestations of consciousness must have deeper quantum origin, with significant psychosomatic implications”.

8a. Quantum brain dynamics and neuronal classical network interconnection

This posits the need to explain how a self-organizing quantum-holographic brain can overlap quantum decoherence and maintain a persistent coherent state for a long time, at room temperature. Hameroff and Penrose’s theory of quantum coherence in microtubules has to go beyond the decoherence cut-off wetware to reach reliability. It is well established experimentally today that the molecules of chlorophyll responsible for the photosynthesis process that transforms light photons in chemical energy can do this with extraordinary efficiency, for about 750 femtoseconds, compared with the 1 to 1.5 femtoseconds frequency of chemical-bond vibrations. This is due to the action of a protein called antenna protein that holds the chlorophyll molecule sustaining the quantum coherence state and suppressing decoherence, by reinducing coherence in decohering parts of the chlorophyll molecule according to Kaufmann [63]. This show us that the capability to suppress decoherence at environment temperature is a common process in nature. So the capability to suppress quantum decoherence must be seen as a natural process in the wet brain, and we must work with the possibility that neurons and glia can sustain a quantum coherent state for milliseconds in the organized cellular complex molecular system full of proteins macromolecules, small molecules, ions and water. Lee et al. [64], have demonstrated that in the vicinity of these macromolecules there is ordered water, and that proteins with a cavity in their 3 D structure can hold one or a few water molecules by means of hydrogen bonds. Beratan [65], studying aqueous tunneling pathways between electron-transfer proteins through quantum chemical computation, shows that these ordered water molecules within and between two proteins separated by 12 to 16 ångstroms permit the occurrence of quantum coherent electron transfer. Jibu and Yasue’s [66] studies on quantum brain dynamics with Umesawa show that “*brain dynamics consists of quantum brain dynamics (i.e. quantum mode) and classical brain dynamics (i.e. classical mode), and that “quantum brain dynamics is the fundamental process of the brain given by quantum field dynamics of the molecular vibrational fields of water molecules and biomolecules”* According to Jibu and Yasue [66], Umesawa introduced in quantum brain dynamics the notion that “*the quanta of the molecular vibrational field of biomolecules are corticons, and the quanta of the molecular vibrational field of water molecules are exchange bosons”*. Quantum coherence can propagate through these vibrational fields of biomolecules and water molecules by non-local information transfer, quantum entanglement and superradiance. As these biomolecular systems are self-organized systems, they have a huge structural and functional redundance, and this creates a quasi-crystalline medium that facilitates the interconnection of the molecular quantum computer networks dynamics with the neuronal classical computer network, i.e. a holoinformational (quantum non-local information plus classical local information) field.

I expanded my conjecture that the interconnectedness between brain and cosmos is a quasi-instantaneous holistic nonlocal connection and proposed the concept of a holoinformational flux, from which both mind and matter are in-formed. In this new concept, quantum holographic brain dynamic patterns are conceived as an active part of the universal quantum-holographic informational field, and capable of generating an informational interconnection that is simultaneously nonlocal quantum-holistic (mind-cosmos holographic connection), and local Newtonian-mechanistic (brain-mind neural networks connections), i.e., holoinformational. Taking yet in consideration the basic mathematical property of holographic systems in which the information of the whole system is distributed in each part of the system, plus Bohm’s holographic quantum physics data, and the experimental data of the holonomic theory of Pribram, we propose that this universal interconnectedness [9,10,31] could permit us to access all the information coded in the wave interference patterns existing in the universe since its origin [see also 7,21,29,30]. This quantum-holoinformational nature of the universe interconnects each part, each brain-mind-consciousness, with all the quantum information stored in the holographic patterns distributed in the whole cosmos, in an indivisible irreducible informational cosmic unity [9,10,31,42,44,45].

9. Consciousness and the Human Mind

The cybernetic network of cyclical hierarchical relations through which we try to characterize life and consciousness is a multilevel dynamic of “*hypercycles*” [67], organizing in “*self-catalytic*” cycles [32,54] in the “*edge of chaos*” [68]. Self-catalytic cycles can organize in higher levels, by means of catalytic hypercycles, (e.g. a virus) capable of evolving into more complex and more efficient structures, until the “*emergence of sets, of sets of... of sets of neurons*” [69]. In this way, the network generates “*creative loops*” [70] and “*hyperstructures*” [71] integrating themselves in systems with patterns of connectivity distributed and parallels, as the “*Global Workspace*” [71-73] and the “*Extended Reticular-Thalamic Activation System*”- ERTAS [72].

Dynamic non-linear systems like the human brain generate these “*neural correlates of consciousness*”, by evolution of physical local “*external*” complexity, as well as by the non-local “*internal*” harmonic unfolding of the universal holoinformational field. This quantum-holographic self-organizing field is self-referential and intelligent, in the same sense as we always say that a DNA molecule is intelligent. This field continuously creates (unfolds) and recreates itself as a holographic distributed medium, and goes on experiencing continuously new holographic possibilities, in an eternal and ever new unfolding-enfolding cycle. The “*self-consistent non big bang cosmology*” of Prigogine-Geheniau et al., describes the main features of this multi-cyclic learning scenario in which the cosmic evolution is the result of an interaction between the quantum vacuum (better see as a *plenum*) and the particles of matter that are synthesized in it. Laszlo [74] adds to this scenario “*the postulate according to which the quantum vacuum is the fifth universal field interacting with matter*” stating that “*the field acts as a holographic medium, registering and conserving the scalar wave-transform of the 3n-dimensional configuration spaces assumed by matter in space*” (pp. 204). Lately Laszlo has been referring to this field as the Akashic Field, in homage to the Vedas. This universal fifth field is not inferred from space-time interactions like the gravitational, the electromagnetic, the strong and the weak nuclear forces. In this new type of field, space and time become implicate, enfolded, as described mathematically by Bohm, in a spectral and holographic organized medium, made of the energy present in the interference patterns of the waveforms. The transformations from space-time order to this spectrum dimension are described by holographic mathematical formulations. This was first described by Leibniz, who created the conception of monads - perhaps the first holographic description in occidental history. Dennis Gabor in the past century described the mathematical principles of holography and defined a quantum of information he named *logon*, a channel which can carry a unit of communication with the least amount of uncertainty.

10. Quantum-Holographic Neural Network Fields

Pribram in his Holonomic Brain Theory [53-55,75-77] describes a holographic process of information treatment, named *multiplex neural hologram*, distributed over the whole brain cortex and dependent on local circuit neurons that do not show long fibers and do not transmit the common nervous impulses. “*They are neurons that work in undulatory way, and are overall responsible for the horizontal connections of the neural tissue’s layers, connections in which holographic interference patterns can be built*” [53]. He describes a “*neural wave equation*” [53] resulting from the workings of the brain’s neural networks, similar to the Schrödinger wave equation of the quantum theory.

Pribram has also demonstrated that hyperstimulation of the fronto-limbic brain allows primates, including humans, to operate in a holistic, holographic-like mode. The electric excitation of these brain areas relaxes the Gaussian constraints, as Laszlo put it. “*While during ordinary levels of excitation of the frontolimbic system the signal processing creates the usual narrative consciousness, when the excitation of this system exceeds a certain threshold, conscious experience is dominated by unconstrained holographic processes. The result is timeless, spaceless, causeless, ‘oceanic’ sensation*”. In these states the nervous system becomes, “*attuned to the holographic aspects of - the holograph-like order- in the universe*” [74]. Electroencephalographic and brain mapping studies made during altered states of consciousness as meditation, prayer, and other brain-mind relaxation techniques, show a high synchronization of the brain waves as if all the neurons of all brain centers were playing the same symphony. In these highly synchronized states of consciousness the holographic brain treatment of information is optimized, facilitating

the interaction of the quantum-holographic brain network with the quantum holographic cosmic network [8, 30].

Pribram demonstrated that the receptor field of the cortical neurons reacts selectively to various sensorial modes, making the harmony curves of adjacent receptors fields to mix as in a piano. In this way the harmony field of the cortex originates a resonance as a string instrument. The mathematical equations that describe the resulting harmony curve are the Fourier transformations that Gabor applied in the creation of the hologram, with a model reconstructed by the application of the inverse process. That holographic organization is what Bohm calls implicate order, a model that includes space and time in its structure as an enfolded dimension. Functioning in this holographic mode, our brain “mathematically builds the objective reality”, interpreting frequencies originating from a spectral dimension, a fundamental information field beyond time and space.

11. Sir John Eccles' Interactive Dualism and Karl Pribram's Monism

Sir John Eccles [56-60] described in the brain fine fiber structures he called *dendrons*, composed of pre-synaptic teledendrons, synapses and post-synaptic dendritical connections, that he postulated could interact with the mind side of the brain-mind interface by way of units he called *psychons*. He proposed that these psychons could operate on synapses through quantum processes, and with Beck [61] developed a beautiful and logical quantum interpretation of the synaptic function. Pribram [53] demonstrated that Eccles' dendrons make up receptive fields in cortical sensory units, that “*as sensory receptive fields they can be mapped in terms of wavelets, or wavelet-like patterns such as Gabor Elementary Functions. Dennis Gabor (1946) called these units Quanta of Information. The reason for this name is that Gabor used the same mathematics to describe his units as had Heisenberg in describing the units of quantum microphysics. Here they define the unity structure of processes occurring in the material brain. However, Gabor invented his function, not to describe brain processes, but to find the maximum compressibility of a telephone message that could be sent over the Atlantic Cable without destroying its intelligibility. The Gabor function thus describes both a unit of brain processing and a unit of communication. Brain is material, communication is mental. The same mathematical formulation describes both. The elementary structure of processing in Eccles' material dendron is identical to the elementary structure of processing of a mental (communication) psychon. There is a structural identity to the dual interactive process.*”

To summarize: The structural identity between a material brain process and a mental communication process is provided by the Gabor “wavelet”. The wavelet instantiates and accounts for the dual interactive process that Eccles and Popper are promoting. Eccles places the interaction within the synapse. This is not contradicted by the emphasis on the receptive field properties of the fine fibered pre and post-synaptic arbors except that the interaction is not limited to the synaptic cleft. Fine fibered membranes are also involved (Jibu and Yasue 1995). This extension overcomes two problems: There is no need to have ineffable, undefined mental processes acting on the synapse; and the energetics involved are brought into the realm of ordinary science.

Pribram proposes a monistic basis for Eccles' dualism, showing that there is an interactive mind/matter duality that is a “ground” from which both matter and mind are “formed“ and the “dual” emerges. That ground functions as a potential reality similar to Heisenberg's “potential world”

“This flux provides the ontological roots from which our experience regarding matter as well as mind (psychological processing) itself become actualized in spacetime”. To illuminate this claim, Pribram relates the following story: “*Once, Eugene Wigner remarked that in quantum physics we no longer have observables (invariants) but only observations. Tongue in cheek I asked whether that meant that quantum physics is really psychology, expecting a gruff reply to my sassiness. Instead, Wigner beamed a happy smile of understanding and replied, “yes, yes, that's exactly correct”. If indeed one wants to take the reductive path, one ends up with psychology, not particles. In fact, it is a psychological process, mathematics, that describes the relationships that organize matter. In a non-trivial sense current physics is rooted in both matter and mind. Communication depends on being embodied, instantiated in some sort of material medium. This convergence of matter on mind, and of mind on matter, gives credence to their common ontological*

root. My claim is that this root, though constrained by measures in spacetime, needs a more fundamental order, a potential order that underlies and transcends spacetime. The spectral basis of both matter and communication portrayed by the Fourier relationship delineate this claim.”

As the brain has the capacity of function in the holographic non-local mode as in the space-temporal local mode, we think that we are dealing here with Bohr's concept of complementarity in the quantum functioning of the central nervous system.

The holonomic brain theory of Pribram, the holographic quantum theory of Bohm, and Laszlo's *akashic field*, show us as part of something much wider than our individual mind. Our mind is a subsystem of a universal hologram, accessing and interpreting this holographic universe. We are fractal-like holographic harmonic systems interacting continuously with this unbroken self-organizing wholeness. We are this holoinformational field of consciousness, and not observers external to it. The external observer's perspective made us lose the sense and the feeling of unity or supreme identity, generating the immense difficulties we have in understanding that we are one with the whole and not just isolated components of it. In this holoinformational model of consciousness the non-local quantum-informational flow in a continuous holomovement of expansion and enfoldment, between the brain and the superimplicate order, is the universal consciousness self-organizing itself as human mind. This non-local quantum-holographic cosmos manifests itself through our consciousness, seeing itself through our eyes, and interconnecting in a participatory holistic and indivisible way the human brain to all levels of the self-organizing multiverse.

12. Qualia and the Hard Problem

The quantum non-local information-essential characteristic of this dynamic process makes the question about the phenomenal quality (qualia) of conscious experience raised by Chalmers [15,17,71], multicontextual and multidimensional, relative not only to the observer, but also to the observation process and to what one observes, that is, to the holographic-distributed information of the whole in question. The level of this informational quality increases or decreases in a fractal-holographic transition, depending on the amount of information contained in the part of the universal hologram observed. The hard problem of consciousness proposed by Chalmers [78] is only difficult and problematic in a local, mechanistic and reductionist Cartesian-Newtonian context in which consciousness and universe are considered separate entities. In a holoinformational context of internal relations, indivisible and non-local, it ceases to exist, because the self-organizing sublevels of the universe that get structured in a mechanistic-local way are understood as secondary manifestations of the harmonic, fractal and holistic non-local nature of the universal holoinformational "continuum". Energy, matter, life and consciousness are this holoinformational field, with fundamental non-local quantum relations, unfolding in myriads of possibilities.

Theoretically this sends us also to the question of the transpersonal unconscious, which could be hypothetically understood this way, as a part of the universal holographic consciousness unfolded in the brain/mind that gets "out of focus", "obscured", when it self-organizes as human consciousness, like in a hologram, in which little parts contains the whole in a less clear way. When the holoinformational consciousness is embodied in the human brain, the quality (qualia) of the perception of the unity/totality (holos) of nature, is reduced, making these aspects remain unconscious, restricting the being's conscial field, and limiting it mentally and symbolically.

Matter, life and consciousness will not be understood by means of a fragmented and reductionist view that considers only the external and mechanistic relationships of nature. This is a perception error, a vision out of the natural flux of the universe, out of the Tao, and already pointed out by the oriental traditions, thousands of years ago, under the name of "*maya*". As symbolical beings we can better understand this process going through the "flower and fruit" metaphor. We can say the fruit comes from the flower. However, the fruit is already implicit in the seed, making it impossible for us to state that it only and essentially comes from the flower. This would be a reductionism, a perceptive fragmentation of reality. Actually, not even the seed originates the fruit. The fruit comes from an indivisible totality, clearly intelligent and holo-related: sun, rain, earth, air, wind, cosmic rays, seasons, weather, microorganisms, insects, birds, seed, sap, steam, leaves... "ad infinitum", in an irreducible holoinformational order.

13. Final Considerations

This quantum-holographic informational, self-organizing view of consciousness show us directions toward a holoinformational theory of consciousness. In this model information is understood as an irreducible principle of the universe with a status more fundamental than energy, matter, space and time. It is the unifying principle, capable of connecting consciousness to the whole universe and to the totality of space and time. It also allows a better understanding of phenomena and theories related to transpersonal consciousness which up to now we could not explain or understand adequately, such as synchronicities, archetypes, the collective unconscious (Jung), near-death experiences (Moody Jr.), premonitory dreams, psychokinesis and telepathy (Rhine), morphogenetic fields and morphic resonance (Sheldrake), extra-cerebral memory (Stevenson), memories of past lives (Weiss) and holotropic mind (Grof) among others.

Brian D. Josephson, Nobel Prize winner in physics, believes that Bohm's theory of the implicate order can even lead someday to the inclusion of God in the scientific framework (personal communication during the debate after my presentation at the international conference CASYS- Computed Anticipatory Systems, in Liège, Belgium in 2007) . This holoinformational view of consciousness which has in Bohm's quantum theory one of its very foundations, implies the inclusion of a Cosmic Consciousness - a Universal Intelligence that originates, permeates, maintains and transforms the universe, life and mind, through the holoinformational process.

Finally, we would like to state that in the Cartesian-Newtonian reductionist paradigm, the question about the nature of consciousness is unanswerable. It can be useful to unfold new knowledge and generate new questions and answers. However, the inherent fragmentation of this perspective increasingly obscures our understanding of what reality and consciousness are.

"We did not come to this world: we came from it, like the leaves of a tree. Like the ocean produces waves, the universe produces people. Each individual is an expression of the whole kingdom of nature, a single action of the total universe. Rarely this is, if at any time it is at all, felt by the majority of the individuals".

Allan Watts

References

1. S. R. Hameroff, Quantum coherence in microtubules: A neural basis for emergent consciousness? *Journal of Consciousness Studies* 1(1) (1994) 91-118.
2. S. R. Hameroff, R. Penrose, Orchestrated reduction of quantum coherence in brain microtubules: A model for consciousness. In *Toward a Science of Consciousness: The First Tucson Discussions and Debates*, S. R. Hameroff, A. W. Kaszniak, A. C. Scott (eds.), MIT Press Cambridge MA, 1996.
3. C. J. S. Clarke, The nonlocality of mind, *Journal of Consciousness Studies* 2(3) (1995) 231-240.
4. H. Umezawa, *Advanced Field Theory*, AIP Press, New York, 1993.
5. K. Wilber, An integral theory of consciousness, *Journal of Consciousness Studies* 4(1) (1997) 71-92.
6. E. Jantsch, *The Self-Organizing Universe*, Pergamon Press, New York, 1980.
7. A. Koestler, *The Ghost in the Machine*, Hutchinson & Co., London, 1967.
8. F. Di Biase, M. S. F. Rocha, Information, self- organization and consciousness: Toward a holoinformational theory of consciousness, In Amoroso R.L. (ed.) *Science and the Primacy of Consciousness: Intimation of a 21st Century Revolution*, Noetic Press, Oakland, 2000; Also published in *The Noetic Journal* 2(3), July 1999, Noetic Press.
9. F. Di Biase, R. L. Amoroso, Holoinformational consciousness: An extension of interactive dualism with anticipatory parameters, *International Journal of Computing Anticipatory Systems* 22 (2008), D.M. Dubois (ed.), CHAOS, Liège, Belgium.
10. F. Di Biase, A holoinformational model of consciousness, *Quantum Biosystems* 3 (2009) 207-220, Italy.
11. F. Di Biase, Quantum-holographic informational consciousness, *NeuroQuantology* 7(4) (2009) 657-664.

12. J. Wheeler, Information, physics, quantum: The search for links”, in *Complexity, Entropy and the Physics of Information*, W. H. Zurek (ed.), Addison-Wesley, Reading MA, 1990.
13. N. Wiener, *Cybernetics, or Control and Communication in the Animal and Machine*, Technology Press & John Wiley & Sons, New York, 1948.
14. C. E. Shannon, W. Weaver, *The Mathematical Theory of Communication*, University of Illinois Press, Urbana, III, 1949.
15. L. Brillouin, *Vie Matière et Observation*, Editions Albin Michel, 1959.
16. D. J. Chalmers, The puzzle of conscious experience, *Scientific American*, Dec. 1995.
17. G. Bateson, *Mind and Nature: A Necessary Unity*, Dutton, New York, 1979.
18. D. J. Chalmers, *The Conscious Mind. In Search of a Fundamental Theory*, Oxford University Press, New York, 1996.
19. H. Atlan, *L’Organization Biologique et la Théorie de L’Information*, Hermann, Paris, 1972.
20. H. Atlan, *Entre le Cristal et la Fumée, Essai sur L’Organization du Vivant*, Seuil, Paris 1979.
21. F. Di Biase, Auto-organização nos sistemas biológicos, *Ciência e Cult.* 33(9) (1981) 1155-1159, Sociedade Brasileira para o Progresso da Ciência, Brazil.
22. F. Di Biase, M. S. F. Rocha, Information, self-organization and consciousness, *World Futures- The Journal of General Evolution* 53 (1999) 309-327, UNESCO—E. Laszlo (ed.), Gordon & Breach Group, U.K.
23. F. Di Biase, M. S. F. Rocha, *Ciência Espiritualidade e Cura – Psicologia Transpessoal e Ciências Holísticas*, Editora Qualitymark Rio de Janeiro, Brazil, 2004.
24. I. Prigogine, I. Stengers, *La Nouvelle Alliance*, Editions Gallimard, Paris, France, 1979.
25. I. Prigogine, I. Stengers, *Entre le Temps et L’Eternité*, Fayard, Paris, France, 1988.
26. W. Seager, Consciousness, information and panpsychism, *Journal of Consciousness Studies* 2(3) (1995) 272-288.
27. W. H. Zurek (ed.), *Complexity, Entropy and the Physics of Information*, Santa Fé Institute, Studies in the Science of Complexity, Vol. 8, Addison-Wesley, Redwood City CA, 1990.
28. T. Stonier, *Information and the Internal Structure of the Universe*. Springer Verlag, New Addison-Wesley, Reading MA, 1990.
29. T. Stonier, *Information and Meaning. An Evolutionary Perspective*, Springer, U.K., 1997.
30. F. Di Biase, *O Homem Holístico, a Unidade Mente-Natureza*, Editora Vozes, Rio de Janeiro, Brazil, 1995.
31. F. Di Biase, M. S. F. Rocha, *Caminhos da Cura*, Editora Vozes, Rio de Janeiro, Brazil, 1998.
32. F. Di Biase, R. L. Amoroso (eds.) *A Revolução da Consciência. Novas Descobertas sobre a Mente no Século XXI*. Editora Vozes, Rio, Brasil, 2005.
33. S. Grof, *Beyond the Brain: Birth, Death, and Transcendence in Psychotherapy*, State University of New York Press, Albany NY, 1985.
34. R.A. Moody, *Life after Life*, Bantam Books, New York, 1976.
35. K. Ring, *Life at Death*, Quil, New York, 1980.
36. M. B. Sabom, *Recollections of Death*, Harper & Row, New York, 1982.
37. E. Kübler-Ross, *On Children and Death*, MacMillan, New York, 1983.
38. F. Capra, *Uncommon Wisdom*, Simon & Schuster, New York, 1988.
39. P. Weil, Axiomática transdisciplinar para um novo paradigma holístico, in *Rumo à nova transdisciplinaridade: sistemas abertos de conhecimento*, Pierre Weil, Ubiratan D’Ambrosio, Roberto Crema, Summus, São Paulo, Brasil, 1993.
40. A. Atkins, On consciousness: what is the role of emergence?, *Medical Hypothesis* 38 (1992) 311-314.
41. D. Bohm, *Wholeness and the Implicate Order*, Routledge, New York, 1983.
42. D. Bohm, *Unfolding Meaning, a weekend of dialogue with David Bohm*, ARK Paperbacks, Routledge & Kegan Paul Ltd, 1987.
43. D. Bohm, B. J. Hiley, *The Undivided Universe*, Routledge, London, 1993.

44. D. Bohm, F. D. Peat, *Science Order, and Creativity. A dramatic New Look at the Creative Roots of Science and Life*, Bantam Books, New York, 1987.
45. R. Weber, The enfolding unfolding universe: A conversation with David Bohm, in *The Holographic Paradigm*, (ed.) K. Wilber, New Science Library, Boulder CO, 1982.
46. N. Gisin, et al. *Science* 277 (1997) 481.
47. S. D. Peat, *Synchronicity, the Bridge Between Matter and Mind*, Bantam Books, New York, 1987.
48. J. Horgan, *The End of Science*, Helix Books, Addison-Wesley, 1996.
49. J. Bell, *Speakable and Unspeakable in Quantum Mechanics*, Cambridge University Press, 1987.
50. Francis H. Cook, *Hua-yen Buddhism: The Jewel Net of Indra*, The Pennsylvania State University Press, 1977.
51. Jibu, M. and Yassue, K., *Quantum Brain Dynamics and Consciousness*, Advances in Consciousness Research, John Benjamins Publishing Company, Amsterdam/Philadelphia, 1995
52. M-W. Ho, *The Rainbow and the Worm, The Physics of Organisms*, 3rd ed., World Scientific, Singapore, 2008.
53. K. Pribram, Esprit, cerveau et conscience, in *Science et Conscience, Les Deux Lectures de L'Univers*. Éditions Stock et France-Culture, Paris, 1980.
54. K. Pribram, *Brain and Perception: Holonomy and Structure in Figural Processing*, Erlbaum, Hillsdale NJ, 1991.
55. K. Pribram, In memoriam: Nobel laureate Sir John Eccles, *The Noetic Journal* 1, June 1997, pp 2-5. Noetic Press, Orinda CA.
56. J. C. Eccles, *The Neurophysiological Basis of Mind*, Oxford University Press, Oxford, 1952.
57. J. C. Eccles, A unitary hypothesis of mind-brain interaction in the cerebral cortex, *Proc. R. Soc. Lond. B* 240 (1989) 433-451.
58. J. C. Eccles, Evolution of complexity of the brain with the emergence of consciousness, In Pribram, K. (ed.) *Rethinking Neural Networks: Quantum Fields and Biological Data*, Lawrence Erlbaum, Manwah, 1993.
59. J. C. Eccles, *Evolution du Cerveau et Création de la Conscience*, ch. 8.8 Une nouvelle hypothèse sur l'interaction esprit/cerveau à partir de la physique quantique: l'hypothèse des micro-sites, Flammarion, Paris, 1994.
60. J. C. Eccles, Do mental events cause neural events analogously to the probability fields of quantum mechanics? *Proc R Soc Lond [Biol]* 227 (1998) 411-428.
61. Beck, F. , Eccles, J.C., Quantum aspects of brain activity and the role of consciousness. *Proc. Natl. Acad. Sci. USA* 89 (1992).
62. D. Raković, *Integrative Biophysics, Quantum Medicine, and Quantum-Holographic Informatics: Psychosomatic-Cognitive Implications*, IASC & IEPSP, Belgrade, 2009; cf. www.dejanrakovic.com
63. S. Kauffman, *At Home in the Universe, The Search for the Laws of Self-Organization and Complexity*, Oxford University Press, New York, 1995
64. H.Lee, Y.C.Cheng, G.R.Fleming, Coherence Dynamics in Photosynthesis: Protein Protection of Excitonic Coherence, *Science* 316 (2007): 1462-5.
65. D. Beratan, J.Lin, I.A.Balabin, D.N.Beratan, The Nature of Aqueous Tunneling Pathways Between Electron-Transfer proteins, *Science* 310 (2005) : 1311-3.
66. Jibu, M. and Yasue, K., The Basics of Quantum Brain Dynamics, In Pribram, K. (ed.) *Rethinking Neural Networks: Quantum Fields and Biological Data*, Lawrence Erlbaum, Manwah, 1993.
67. M. Eigen, P. Schuster, *The Hypercycle. A principle of Natural Self-Organization*, Springer-Verlag, Berlin, 1979.
68. R. Lewin, *Complexity: Life on the Edge of Chaos*, MacMillan, New York, 1992.
69. A. Scott, *Stairway to the Mind. The Controversial New Science of Consciousness*, Copernicus, Springer-Verlag, New York, 1995.
70. E. Harth, *The Creative Loop. How the Brain Makes a Mind*, Addison-Wesley, Reading MA, 1993.
71. B. J. Baars, *In the Theater of Consciousness: The Workspace of the Mind*, Oxford University Press, 1997.
72. J. Newman, Putting the puzzle together. Part I: Towards a general theory of the neural correlates of consciousness, *Journal of Consciousness Studies* 4 (1) (1997) 47-66.

73. J. Newman, B. J. Baars, A neural attentional mode access to consciousness: A global workspace perspective, *Concepts in Neuroscience* 4(2) (1993) 255-290.
74. E. Laszlo, *The Creative Cosmos, A Unified Science of Matter, Life and Mind*, Floris Books, Edinburgh, U.K., 1993.
75. K. Pribram, The neurophysiology of remembering, *Scientific American* 220, Jan. 1969, pp. 75.
76. K. Pribram, *Languages of the Brain*, Wadsworth Publishing, Monterey CA, 1977.
77. K. Pribram (ed.), *Rethinking Neural Networks: Quantum Fields and Biological Data*, Lawrence Erlbaum Associates, Hillsdale, 1993.
78. Amoroso, R.L., & Rauscher, E. (2009). *The Holographic Anthropic Multiverse*, Singapore: World Scientific.
79. Amoroso, R.L. (ed) (2010) *Complementarity of mind and body: Realizing the dream of Descartes, Einstein and Eccles*, New York: Nova Science.