

A Holoinformational Model of Consciousness

Francisco Di Biase

Albert Schweitzer University, Switzerland;
World Information Distributed University, Belgium;
Clínica Di Biase, Barra do Piraí, Rio de Janeiro, Brazil
email: dibiase@terra.com.br

ABSTRACT

The author propose a quantum-informational holographic model of brain-consciousness-universe interactions based in the holonomic neural networks of Karl Pribram, in the holographic quantum theory developed by David Bohm, and in the non-locality property of the quantum field described by Hiroomi Umezawa. I consider this model an extension of the interactive dualism of Sir John Eccles, of an interconnection between brain and spirit by means of quantum microsites named *dendrons and psychons*. I propose a dynamic concept of consciousness seen as a holoinformational flux interconnecting the holonomic informational quantum brain dynamics, with the quantum informational holographic nature of the universe. This self-organizing flux is generated by the holographic mode of treatment of neuronal information and can be optimized through practices of deep meditation, prayer, and others states of higher consciousness that underlie the coherence of cerebral waves. In brain mapping studies performed during the occurrence of these harmonic states we can see the spectral array of brain waves highly synchronized and perfectly ordered like a unique harmonic wave, as if all frequencies of all neurons from all cerebral centers played the same symphony. This highly coherent brain state generates the non-local holographic informational cortical field of consciousness that interconnect the human brain and the holographic cosmos. The comprehension of this holonomic quantum informational nature of brain-consciousness-universe interconnectedness allows us to solve the old mind-matter cartesian hard problem, unifying science, philosophy, and spiritual traditions in a more transdisciplinary, holistic, integrated paradigm. In this new arrangement cosmovision, consciousness and transpersonal phenomena becomes part of Science and of the very holoinformational nature of the Holographic Conscious Multiverse.

INTRODUCTION

Here I present a quantum-informational holographic model of brain-consciousness-universe interaction based on the holonomic neural network model of Karl Pribram (1969; 1977; 1980; 1991; 1993; 1997a; 1997b) and relying on the ontological interpretation of quantum theory developed by David Bohm (1983; 1987a; 1987b; 1993), with extended nonlocal properties of the quantum field as described by Hiroomi Umezawa (1993). I consider this model an extension of the interactive dualism developed by Sir John Eccles (1952; 1989; 1993; 1994; 1998) and extended by Richard Amoroso and me (Amoroso, 1999; 2000; 2003a; 2003b; Di Biase & Amoroso, 2008). Eccles' idea of an interconnection between brain and spirit by means of quantum microsites named *dendrons* (bundles of nerve dendrites) *that couple to psychons*, (Eccles philosophical construct of mind that interacted with or coupled to brain dendrons has deeply influenced the development of my conception of consciousness (Eccles, 1981; 1995; 2000; 2004; 2005; 2008). I propose a dynamic concept of consciousness seen as a holoinformational flux interconnecting the holonomic informational Quantum Brain Dynamics (QBD) (Di Biase, 2000; 2008), with the quantum informational holographic nature of the universe. This self-organizing flux (Di Biase, 1981; Jantsh, 1984; Varela, Maturana & Uribe, 1974) is generated by a holographic mode of neuronal information that can be optimized through practices of deep meditation, prayer, and other states of higher consciousness. The quantum potential in Bohm's ontological interpretation of quantum theory is a guidance principle (called the pilot wave by de Broglie) and was introduced to 'steer' evolution of the wave function of which may effect the coherence of cerebral waves (Bohm, 1995; 2000; 2005; 2008).

Brain mapping studies performed during the occurrence of these harmonic states have shown a highly synchronized and perfectly ordered spectral array of brain waves that form unique harmonic waves, as if all frequencies of all neurons from all cerebral centers played the same symphony. This highly coherent brain state generates the nonlocal holographic informational cortical field of consciousness interconnecting the human brain and the holographic undivided cosmos as proposed by Bohm & Hiley (1993). The comprehension of this holonomic quantum informational nature of brain-consciousness-universe interconnectedness allows us to solve the historic mind-matter Cartesian hard problem (Chalmers, 1995a; 1995b; 1996), unifying science, philosophy, and spiritual traditions in an expanded transdisciplinary, holistic, paradigm. In this new cosmivision, consciousness and transpersonal phenomena becomes parts of

science and of the very holoinformational nature of the universe (Di Biase & Rocha, 2000; Amoroso, 2003b).

In this holoinformational cosmovision brain and universe are conceived as quantum-holographic-informational systems interconnected by an instantaneous universal nonlocal holoinformational flux. This instantaneous holoinformational brain-cosmos dynamics is based on three pillars of modern science:

- 1) The holographic neural network processing of brain systems described by neuroscientist Karl Pribram (1987; 1980; 1993; 1997a; 1997b).
- 2) The quantum-holographic theory of the universe developed by physicist David Bohm (1983; 1987a; 1987b; 1993).
- 3) The quantum principle of nonlocality developed by physicist Hiroomi Umezawa, in his theory of the quantum field (1993).

For a more comprehensive exposition of my text I am going initially to define the terms nonlocality and holographic.

Nonlocality is a fundamental property of the universe, proved to exist at the quantum and macroscopic level, responsible for instantaneous interactions between all cosmic phenomena - a mathematical consequence of Umezawa's Quantum Field Theory (1993) that unifies the electromagnetic, nuclear and gravitational fields in a subjacent indivisible totality.

Quantum Field Theory explains all subatomic, atomic, microscopic and even macroscopic phenomena, as well as superconductivity and lasers; and is considered the most fundamental physical theory of the universe. Besides being mathematically similar to the gravitational and electromagnetic fields, the quantum field doesn't exist physically in 3D spacetime giving rise to its peculiar nonlocal property. As a nonlocal phenomenon it influences instantaneously all others regions of spacetime, without necessity of any change of energy.

According to classical and relativistic physics nonlocal phenomena do not exist. This theoretical impossibility generated the famous Einstein-Bohr controversy and the celebrated Einstein-Podolski-Rosen (EPR) Paradox. Einstein and his associates wouldn't admit that quanta or information could travel faster than light and created a thought experiment to demonstrate that quantum physics was therefore incomplete. But contrary to their initial proposition, the existence of nonlocality has been dramatically and convincingly proven to exist in modern physics experiments. According to Bohr, if an atom simultaneously emits two opposite spin particles, and if we alter the spin of one, even if they are separated

by an enormous distance (for instance, one in a lab on Earth and the second on the other side of the galaxy), the spin of the second is instantaneously modified.

In 1982 French physicist Alain Aspect (1982), clearly demonstrated the existence of this instantaneous nonlocal action between two photons emitted by one atom. More recently Gisin (1997) and coworkers proved the existence of instantaneous nonlocal quantum actions in macroscopic scale. This faster-than-light communication unveiled a holistic nonlocal quantum-informational interaction between all particles in the universe.

Holographic systems are systems that can generate three-dimensional virtual images. The virtual image or hologram is created when a laser falls upon an object and reflects on a plate and a second laser or rectilinear reflected beam falls on this plate generating a mix of the waves from the two beams. This wave interference pattern stores all the information about the form and volume of the object, and when it is reflected it generates a three-dimensional image of the object in space. The relevancy for us is that we can prove mathematically and experimentally that in holographic systems information about the whole system is distributed in each part of the system. If we break the holographic plate, each part of it will display the entire three-dimensional image of the object in space, showing us that in holographic systems the whole is in the parts as each part is in the whole.

These holographic transformations form spacetime order from a spectral dimension of frequencies the description of which is dependent on the pioneering mathematical formulations first described by a concept called monads developed by Leibniz. In the Twentieth Century Dennis Gabor described the mathematical principles of holography, winning him a Nobel Prize. The mathematical formulations that describe the harmonic curve resulting from the interference pattern of waves are called Fourier transformations, after the 18th century French mathematician that described it. Gabor applied Fourier transformations to the creation of the hologram showing how Fourier transforms of the interference pattern can be used to rebuild the virtual image of the object by the application of the inverse process. Gabor showed that from a dimension of frequencies objects in spacetime can be rebuilt in a virtual form.

HOLOGRAPHIC NEURAL NETWORK FIELDS

Karl Pribram (1977; 1991; 1993) has demonstrated with his holonomic theory of brain dynamics that the cerebral cortex is the site of a holographic information process he calls a multiplex neural hologram that is dependent on

local circuits of neurons without long fibers that do not transmit ordinary nervous impulses. “These neurons function in the undulatory mode and are above all responsible by the horizontal layer connections of the neural tissue where holographic interference patterns can be built” (1993). Pribram presents evidences that at the level of conscious experience, information processing in the brain is basically Gabor-like rather than binary (as in Shannon’s information measurement theory). He shows that the process takes place in a phase space created by a multiply interconnected web of teledendrons, synapses and dendrites, called synaptodendritic web.

The neural hologram is build by the interaction of the electromagnetic fields of the neurons similarly to the interaction of sound waves in a piano. When a piano is played the keys strike the strings generating a vibrational standing wave between the two ends of the string, creating an interference pattern (This interference can be destructive or constructive). Nodes of constructive interference, of these sound frequencies, create the harmony or harmonics that are the notes making up the music we listen to. Pribram has demonstrated that a similar process is continuously occurring in the cerebral cortex by means of the interpenetration of the electromagnetic fields of the adjacent cortical neurons, generating a harmonic field. According to Pribram’s model his harmonic electromagnetic field distributed in the cerebral cortex, holographically stores and encodes a huge information field responsible for the emergence of memory and consciousness. As the music is not in the piano but in the resonating field that surrounds it, so our memories and consciousness are not in the brain, but in the holographic information field that surrounds it.

Pribram’s *neural wave equation* (1997a; 1997b) describing holographic neural network processing is similar to the Schrödinger wave equation of quantum theory with the addition of the de Broglie-Bohm Quantum Potential. This is not coincidental and opens the possibility of holographic interaction between receptive fields in the cortex with the holographic quantum universe described by David Bohm. This new holographic paradigm allows us to rethink the manner in which information processing occurs in the nervous system. In this context, Pribram’s quantum holonomic theory of brain function is one of the most brilliant and revolutionary contribution to neuroscience in the 100 years since the initial studies of Sherington.

INFORMATION

The notion of information implies a certain ambiguity, meaning the bit capacity of a physical system (Shannon), 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 to us, the uncertainty about the system

The classical theory of information situated at the level of "bit capacity", is unable to provide the proper connection to non-local information and consciousness (Clark, C.J.S., 1995).

So we need a more radical view of information for a more radical view of the fundamental nature of consciousness.

NON-LOCAL QUANTUM INFORMATION

According to Bohm, De Broglie's model is a new type of field, which activity is dependent upon the information content that is conducted to the whole experimental field. Adding to its equations a Quantum Potential that satisfies Schrödinger's equation, that depends on the form but not on the amplitude of the wave function, Bohm developed a model in which this quantum potential, carries "active information" that "guides" the particle along its way. This quantum potential is subtle in its form and does not decay with the distance.

INFORMATION PHYSICS

Developed by Wojciech Zurek (1990) and others, propose that the physical entropy would be a combination of two magnitudes that compensate each other:

- 1-the observer's ignorance, measured by Shannon's statistical entropy
- 2-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 reduced, as a result of the increase in bit numbers in its memory, remaining, however, constant the sum of these two magnitudes, that is, the physical entropy.

QUANTUM INFORMATIONAL VIEW OF THE UNIVERSE

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.

This informational view of the universe shows us the necessity of a "Law of Conservation of Information" as well as or more fundamental than the law of conservation of energy.

Stonier (1990) states that: *Information is the cosmical organizational principle with a "status" equal to matter and energy.*

In another paper (Di Biase & Rocha, 2000), I defined information as "*a intrinsic, irreducible and non-local, property of the universe, capable of generate order, self-organization and complexity*".

Chalmers (1995a; 1995b), also defines consciousness as "*an irreducible aspect of the universe, like space and time and mass*".

Based on these implications of the quantum informational view of the universe I propose that consciousness is non-local information with a status equal to matter and energy.

THE HOLOGRAPHIC MULTIVERSE

The mathematical formulations that describe the harmonic slope resulting from wave interference are Fourier transformations that Dennis Gabor applied to the development of the hologram, enriching it by the application of the inverse process, a model in which the interference pattern rebuilds the object in a virtual image. In other words, from the spectral dimension of frequency one can reconstruct mathematically and experimentally the object in spacetime dimensions.

This holographic organization mode is also what Bohm applied to quantum theory to develop his holographic quantum theory of the universe. In Bohm's universe model, space and time are mixed, "folded" into a dimension of frequencies that is an implicit hidden order without spacetime relations. In this field of frequencies dimensional fluctuations occur, more intense "*undulations*" like holographic patterns, to build a spacetime dimension (Peat, 1987) This explicit order is our manifest universe. According to Bohm (1987a):

"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 enfoldment 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”.

TOWARDS A HOLOINFORMATIONAL THEORY OF CONSCIOUSNESS

Experimental research developed by Pribram and other consciousness researchers like Hameroff (1994), Hameroff and Penrose (1996), Jibu and Yassue (1993; 1995), 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 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. These quantum dynamics show us that the interaction process between dendrons and psychons, described by Eccles, are not limited to the synaptic cleft, as stated by Eccles, but a much wider embodiment throughout the whole brain. Psychons are presumed to operate on synapses by way of quantum processes.

Pribram (1991) demonstrates good evidence that Eccles' dendrons make up receptive fields in cortical sensory units. Dendrons are composed of pre-synaptic teledendrons, synapses and post-synaptic dendrites. They compose the fine fiber structure wherein brain processing occurs. As Pribram (1991), put it “*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”.

Like Pribram, I see this quantum holographic interactions not as a contradiction but as a natural extension of Eccles ideas(1993;1994;1998).

I expanded my conjecture that the interconnectedness between brain and cosmos is an instantaneous nonlocal connection and to the concept of a holoinformational flux, from which both mind and matter are in-formed, that resembles Bohm’s holomovement. But 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 field interconnection that is simultaneously nonlocal (quantum-holistic) and local (Newtonian-mechanistic), 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 (Laszlo, 2003) could permit us to access all the information (Di Biase & Amoroso, 2008) codified in the wave interference patterns existing in all the universe since its origin. The quantum-holoinformational nature of the universe interconnects each part, each brain-consciousness, with all the information stored in the holographic patterns distributed in the whole cosmos, in an indivisible irreducible informational cosmic unity (Bohm & Hiley,1993; Di Biase & Rocha, 2000).

As a consciousness exercise, analogous to Einstein’s thought experiments, we could compare this universal informational interconnectedness with the following metaphoric quotations from various spiritual traditions: *As above so below* (Alchemy). *All that is outside is inside* (Upanishads). *The father is inside us* (Christianity). *As in the earth so in the heavens* (Christianity). This universal interconnectedness could be perfectly understood as a Cosmic Holographic Consciousness.

Consciousness in this conception is the holoinformational non-local flux that permits the interaction of the Holonomic Informational Quantum Brain Dynamics - that we can consider as Eccles’s extended dendrons - with the quantum-holographic nature of the universe, that we can view as an extended cosmic psychon.

As I have already put Pribram states, that as sensory receptive fields dendrons can be mapped in terms of Gabor’s Elementary Functions or wavelet-like patterns, and Gabor called these unities Quanta of Information, because he used the same mathematics to describe it as Heisenberg did in describing units of quantum physics. Yet Pribram (Amoroso, 2000) shows:

They define the unit 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 .

Richard Amoroso, (1999; 2000a; 2000b), creator of Noetic Field Theory tell us that “Consciousness pervades atoms, is the organizing power deeper than gravitation (unitary field), that frames the universe, causes gravitation, and the flux or *élan vital* which gives life and is the ‘light of the mind’... this basic holistic framework incorporates the implicate and explicate order described by Bohm” (1983; 1993). This noetic definition of consciousness is as radical as our holoinformational consciousness, and I think we are saying the same thing with different approaches.

TRANSPERSONAL STATES OF CONSCIOUSNESS AS HIGHLY SYNCHRONIZED HARMONIC BRAIN STATE

Through practices of deep meditation, prayer, and others states of higher consciousness that elevates the coherence of cerebral waves, this universal interconnectedness becomes expanded by synchronizing the functioning of the cerebral hemispheres and unleashing a highly coherent brain state that optimizes the holographic treatment of neuronal information. In brain mapping studies this highly synchronized harmonic state shows brain waves highly synchronized and perfectly ordered, in a unique harmonic wave, as if all frequencies of all neurons from all cerebral centers played the same symphony. In my concept this highly harmonic synchronized state generates a nonlocal holographic informational cortical field creating a holoinformational flux of consciousness interconnecting the human mind with the Holographic Cosmic Consciousness. A survey of these electroencephalographic and clinical studies can be found in my Portuguese books (Di Biase & Rocha, 1998; 2000; 2004), and the mathematics of it can be view in a recent paper I published with Richard Amoroso, we presented in Belgium (Di Biase & Amoroso, 2008).

REFERENCES

- Amoroso, R L (1999) An introduction to noetic field theory: The quantization of mind, *The Noetic J* 2:1, pp. 28-37
- Amoroso, R L, (2000a) Consciousness, a radical definition: Substance dualism solves the hard problem, In Amoroso, (ed.), Pribram, K H, Grof, S, Sheldrake, R, Goswami, A, Di Biase, F, *Science and the Primacy of Consciousness*, Orinda: Noetic Press
- Amoroso, R L et al, (ed) (2000b) Pribram, K, Grof, S, Sheldrake R, Goswami, A, Di Biase, F, *Science and the Primacy of Consciousness*, Orinda: Noetic Press.
- Amoroso, R L (2003a) The Fundamental Limit and Origin of Biological Systems, *Noetic Journal* 4:1; 24-32
- Amoroso, R L (2003b) The physical basis of qualia: Overcoming the 1st person 3rd person barrier, *Noetic Journal* 4:3, pp. 212-230
- Aspect, A, et al (1982) *Phys. Rev. Lett.* 47, 460; 1982, *Phys. Rev. Lett* 49, 91; (1982) *Phys. Rev. Lett* 49, 1804
- Bohm, D (1983) *Wholeness and the Implicate Order*, Routledge, New York
- Bohm, D (1987a) *Unfolding Meaning, a weekend of dialogue with David Bohm*. ARK, Paperbacks, Routledge & Kegan Paul Ltd.
- Bohm, D and Peat, F D (1987b) *Science Order, and Creativity*, New York: Bantam
- Bohm, D & Hiley, B J (1993) *The Undivided Universe*, London: Routledge
- Chalmers, D J (1995a) Facing up to the problem of consciousness, *J Consciousness Studies*, 2:3, 200-19
- Chalmers, D J (1995b) The puzzle of conscious experience, *Scientific American*, December

Chalmers, D J (1996) *The Conscious Mind: In Search of a Fundamental Theory*, New York: Oxford Univ. Press

Clarke C J S (1995) The Nonlocality of Mind, *J Consciousness Studies*, 2:3, 231-240

Di Biase, F (1981) Auto-organização nos sistemas biológicos, *Ciência e Cult.*, 339: 1155-1159, Sociedade Brasileira para o Progresso da Ciênci

Di Biase, F (1995) *O Homem Holístico, a Unidade Mente-Natureza*, Rio de Janeiro: Editora Vozes

Di Biase, F & Rocha, M S (1998) *Caminhos da Cura*, Petrópolis, Rio de Janeiro: Editora Vozes

Di Biase, F & Rocha, M S (2000) Information Self-Organization and Consciousness: Toward a Holoinformational Theory of Consciousness, in Amoroso RL et al, (eds.) *Science and the Primacy of Consciousness: Intimation of a 21st Century Revolution*, Oakland: Noetic Press

Di Biase, F & Rocha, M S (2004) *Ciência Espiritualidade e Cura-Psicologia Transpessoal e Ciências Holísticas*, Rio: Editora Qualitymark

Di Biase, F, Amoroso, R L (eds.) (2005) *A Revolução da Consciência. Novas Descobertas sobre a Mente no Século XXI*. Editora Vozes, Rio, Brasil

Di Biase, F, Amoroso, R L, 2008, Holoinformational Consciousness: An Extension of Interactive Dualism with Anticipatory Parameters. *International Journal of Computing Anticipatory Systems*, Vol. 22, Edited by D.M. Dubois, CHAOS, Liège, Belgium

Eccles, J C (1952) *The Neurophysiological Basis of Mind*, Oxford University Press, Oxford

Eccles, J C (1989) A unitary hypothesis of mind-brain interaction in the cerebral cortex, *Proc. R. Soc. Lond. B* 240, pp. 433-451

Eccles, J C (1993) Evolution of Complexity of the Brain with the Emergence of Consciousness, In Pribram, K. (ed.) *Rethinking Neural Networks: Quantum Fields and Biological Data*, Manwah: Lawrence Erlbaum

Eccles, J C (1994) *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

Eccles, J C (1998) Do mental events cause neural events analogously to the probability fields of quantum mechanics? *Proc R Soc Lond [Biol]* 227:411-28

Gisin, N et al (1997) *Science*, vol. 277, pg 481

Hameroff, S R (1994) Quantum Coherence In Microtubules: A Neural Basis for Emergent Consciousness?, *J of Consciousness Studies*, 1, No.1, Summer

Hameroff, S R & Penrose R (1996) Orchestrated Reduction of Quantum Coherence in Brain Microtubules: A Model For Consciousness, In *Toward a Science of Consciousness: The 1st Tucson Discussions and Debates*, S.R.Hameroff, A.W. Kaszniak, & A.C. Scott, (eds.), Cambridge: MIT Univ. Press

Jantsch, E (1984) *The Self-Organizing Universe*, New York: Pergamon

Jibu, M, Yasue, K (1993) *The Basics of Quantum Brain Dynamics*, in Pribram, K (ed.) *Rethinking Neural Networks: Quantum Fields & Biological Data*, Manwah: Lawrence Erlbaum

Jibu, M & Yasue, K (1995) *Quantum Brain Dynamics and Consciousness*, Amsterdam: John Benjamins

Laszlo, E (2003) *The Connectivity Hypothesis*, N.Y: State Univ. New York Press

Peat, D (1987) *Synchronicity, the bridge between matter and mind*, New York: Bantam

Popper, K R & Eccles, J C (1977) *The Self and Its Brain*, Berlin: Springer-Verlag

Pribram, K (1969) *The Neurophysiology of Remembering*, *Scientific American* 220, Jan

Pribram, K (1977) *Languages of the Brain*, Monterey, Calif., Wadsworth Publishing

Pribram, K (1980) *Esprit cerveau et conscience*, in *Science et Conscience*, Les deux lectures de l'univers. Editions Stock , Paris

Pribram, K (1991) *Brain and Perception: Holonomy and Structure in Figural Processing*, Hillsdale: Erlbaum

Pribram, K Ed (1993) *Rethinking Neural Networks: Quantum Fields and Biological Data*, Hillsdale: Lawrence Erlbaum Associates

Pribram, K (1997a) In Memoriam: Nobel Laureate Sir John Eccles, *The Noetic Journal*, Vol. 1, June, pp 2-5. Noetic Press, Orinda

Pribram, K (1997b) What is Mind that the Brain May Order It?, *The Noetic Journal*, Vol.1,p72

Stonier, T (1990) *Information and the Internal Structure of the Universe*. Springer Verlag, New Addison-Wesley, Reading, Mass

Umezawa, H (1993) *Advanced Field Theory*, New York: AIP Press.

Varela, F G, Maturana, H R & Uribe, R (1974) Autopoiesis: The organization of living systems, its characterization and a model, *BioSystems*, 5, 187-196.

Wheeler, J (1990) Information, Physics, Quantum: The Search for Links, in *Complexity, Entropy, and the Physics of Information*, Wojciech H. & Zurek (eds), Reading: Addison-Wesley

Zurek, W H ed (1990) *Complexity, Entropy and the Physics of Information*. Santa Fé Institute. *Studies in the Science of Complexity*, Vol.8, Redwood City: Addison-Wesley