Macroscopic Quantum Effects in Biophysics and Consciousness

Dejan Rakovic¹,⁴, Miroljub Dugic²,⁴, Milan M. Cirkovic³

Abstract
It is shown that investigations in the field of microwave resonance stimulation of the acupuncture system, as well as investigations of the interactions of consciousness with microscopic and macroscopic environment - imply the existence of local and nonlocal macroscopic quantum biophysical effects, with great potential implications in medicine, psychology, biology, physics, engineering, and philosophy/religion. The parallels between classical and quantum Hopfield-like neural networks were also emphasized, as well as biophysical quantum-relativistic model of altered and transitional states of consciousness, the roots of relative metatheory of consciousness in the quantum decoherence theory, and anthropic "coincidences" in classical and quantum cosmology.

Key Words: macroquantum, local, nonlocal effects, classical & quantum Hopfield-like neural networks, nonlinearity, nonlocality of the wave function, collapse, macroquantum aspects of consciousness, altered, states of consciousness, quantum decoherence, theory anthropic coincidences

Introduction
One century elapsed from the first discoveries of the quantum aspects of Nature, and quantum laws of microworld have got enormous technological applications in semiconductor microelectronics and measurements, optoelectronics and laser technique, computers and telecommunications, with a tendency of further expansion through miniaturization of semiconductor devices till nanometer dimensions. Discoveries of low-temperature and high-temperature semiconductors revealed that quantum effects can be macroscopic as well, with possibility of much wider application of quantum technologies, especially in electroenergetics and transport, and also in microelectronics and measurements of ultrahigh speed and accuracy.

Faculty of Electrical Engineering, P.O.Box 35-54, Belgrade, Serbia, Yugoslavia, ¹ Faculty of Science, Department of Physics, P.O. Box 60, Kragujevac, Serbia and Montenegro, ² Astronomical Observatory, Volgina 7, Belgrade, Serbia and Montenegro. ³International Anti-Stress Center (IASC), Smiljaniceva 11, Belgrade, Serbia and Montenegro. E-mail: info@iasc-bg.org.yu
Initially, quantum mechanics appeared as a theory of microscopic physical systems (elementary particles, atoms, molecules) and phenomena at small space-time scales; typically, quantum phenomena are manifested at dimensions smaller than 1 nm and time intervals shorter than 1 μs. However, from the very beginning of the quantum-mechanical founding the question of its universality was raised, i.e. the question of general validity of the quantum-physical laws for macroscopic phenomena as well, usually treated by the methods of classical physics. In the history of quantum physics, and especially quantum mechanics, this question has been temporarily put aside for very different reasons, being considered as a difficult scientific problem. The situation is additionally complicated by the existence of different schools of quantum mechanics, arguing about physical-epistemological status of the so called collapse (reduction) of the wave function. In this respect the situation is not much better today, and it can be said freely that the problem of universal validity of quantum mechanics is still open.

Starting from the 1980’s, mainly in the papers of Leggett (1980, 1986; Leggett and Garg 1985; Leggett et al. 1987), a new period in investigation of quantum-mechanical phenomena on the macroscopic level began. Namely, a clarification of the notions and planning of experimental situations for observing some physical effects started. The central problem in this respect is a notion of macroscopic differentiation of the states of quantum system whose quantum-mechanical behavior is explored. More precisely, Leggett argues that the term macroscopic quantum-mechanical effect must be related to macroscopically different states, i.e. the system states (and observables) that carry macroscopic properties (and behaviors) of the system as a whole. These states (i.e. observables) must carry classical-physical behavior of the system as well, this posing a task for choosing physical conditions giving rise to observation of typical quantum effects related to these states. Therefore a difference between macroscopic quantum phenomena: the ones usually explored by the methods of (quantum) statistical physics and not related to macroscopically differentiated states (being classified as macroscopic quantum phenomena of the first kind), and those ones regarding macroscopically different (differentiated) states (being classified as macroscopic quantum phenomena of the second kind, and being interesting to us). Numerous different macroscopic quantum phenomena of the second kind, some of them belonging to the fast developing field of the quantum computing and information, unequivocally sharpen the overall problem of universal validity of quantum mechanics.

In the context of macroquantum effects in biophysics, investigations at the end of 20th century in the field of microwave resonance stimulation of acupuncture system, as well as studies of consciousness interactions with microscopic and macroscopic environment - revealed the existence of novel local and nonlocal macroscopic quantum biophysical effects, with far reaching potential implications in medicine, psychology, biology, physics, engineering, philosophy and religion.

---

1 Paradigm of macroscopic, macroscopically differentiated states, are proper states of position (and impulse) of the center of mass of manyparticle system. On the contrary, so called relative coordinates (as observables) neither define macroscopically differentiated states nor carry classical behavior of the system, in any known physical theory or experimental situation.
LOCAL MACROSCOPIC QUANTUM BIOPHYSICAL EFFECTS:

Microwave resonant stimulation of the acupuncture system

Microwave Resonance Therapy (MRT) is a contemporary technology of the acupuncture stimulation, which represents a synthesis of the ancient Chinese traditional knowledge in medicine (acupuncture) and recent breakthroughs in biophysics: affecting the appropriate acupuncture points by the generation of high frequency microwaves (52-78 GHz), remarkable clinical results in prevention and therapy of stress, as well as of many psychosomatic disorders were achieved. MRT appears under different synonyms: short waves therapy, millimeter therapy, information wave therapy ... The method originates from the former Soviet Union, and first investigations in 1960's, resulted in construction of the first generation of MRT generators, were not related to their medical application but to military industry and satellite communications. Interest for influence of electromagnetic (EM) microwave (MW) radiation upon nonhuman biological objects appeared shortly afterwards (Zalubovskaya (1970) in Kharkow, Devyatkov et al (1973) in Moscow). However, the necessity for application of MRT upon acupuncture points was discovered only in the early 1980's in Kiev (Andreyev, Bely, and Sit'ko 1982; Sit'ko, Andreyev, and Dobronravova 1988; Sit'ko and Gizhko 1991; Sit'ko and Mkrtchian 1994) as appearance of sharply-resonant characteristic eigenfrequencies of human organism - which successfully stimulated development of the second generation of coherent and third generation of noise spectrum MW generators. Sit'ko and collaborators presented the MRT officially in 1989 at the international symposium in Kiev, where international multidisciplinary expert committee headed by Frohlich announced MRT as a perspective approach in the regulation of living systems and MRT clinical results highly efficient, and shortly afterwards the MRT was presented and introduced worldwide.

The quantum-coherent characteristics of MRT therapy should be especially pointed out: (1) highly resonant MW sensory response of the disordered organism sensitive to small changes in the frequency (0.01-0.1%) of the manually adapting coherent MRT devices; (2) biologically efficient nonthermal MW radiation of the extremely low intensity (up to $10^{-9}$ W/cm$^2$) and energy (up to $10^{-4}$ eV); and (3) neglecting MW energy losses alongside acupuncture meridians (~ 1 m). On the basis of these empirical data, Sit'ko and collaborators has proposed that acupuncture system is a macroscopic quantum dynamic structure (Andreyev, Bely, and Sit'ko 1982; Sit'ko and Mkrtchian 1994) which might simply be visualized (Jovanovic-Ignjatic and Rakovic 1999; Rakovic et al. 2000) as differentiated at the locations of maxima of three-dimensional standing waves, formed as a result of the reflection of coherent MW Frohlich excitations of molecular subunits in the cell membranes, proteins, microtubules etc. (Frohlich 1968, 1991). This is supported also by other investigations which have demonstrated that differentiation of gap junctions (GJ) channels (of higher density at acupuncture points; see Li, Mashansky, and Mirkin 1989) - as evolutionary older type of intercell communication, which transmits metabolites and regulatory molecules between nonexcitable cells, and ionic electric signals (presumably by combined classical-ionic/quantum-solitonic mechanisms; Kekovi et al. 2004) between excitable cells (of the cardiac muscle, smooth muscles, epithelial liver cells, neurons with electrical synapses, and acupuncture points and meridians) - might be slightly sensitive to voltage (Kandel, Siegelbaum, and Schwartz 1991; Benett et al. 1991).

In that context the explanation for efficiency of the MRT, as noninvasive nonmedicamentous medical treatment, should be sought (Jovanovic-Ignjatic and Rakovic 1999; Rakovic et al. 2000): some disorders in the organism give rise to deformation in the standing wave...
structure of electrical field of the organism in MW region, which influences corresponding changes in spatial structure of the acupuncture system, and consequently its resonant frequencies, resulting in some disease. During the therapy, applying the MW sound at corresponding acupuncture points the excited acupuncture system of the patient is relaxing to the previous healthy condition, while reaching the normal resonant frequencies responses upon the wide spectrum MW source - and following to physiological mechanisms of the acupuncture regulation (Škokljev 1976; Portnov 1982; Omura 1982; Xinnong 1987) the organism biochemically overcomes the disease.

The quantum-coherent characteristics of MRT therapy suggest that healthy condition might be considered as an absolute minimum (ground state) of Št’ko nonlocal selfconsistent macroscopic quantum potential of the organism, while some disorders of an acupuncture system correspond to higher minima of the (spatio-temporally changeable) potential hypersurface in energy-configuration space - this being possible explanation of higher MRT sensory responses of the more excited (more disordered) acupuncture system, and poor MRT sensory response of the healthy acupuncture system being already in the ground state (Jovanovic-Ignjatic and Rakovic 1999; Rakovic et al. 2000). Such a picture is very close to those of associative neural networks in their energy-configuration spaces, and pattern recognition as a convergence of the network towards corresponding bottom of the potential hypersurface, as a memory attractor of the neural network (Hopfield 1982; Peruš 1996; Peruš and Dey 2000). Thus, the process of psychosomatic disorder might be considered as writing and deepening of the corresponding memory attractor, while the process of MRT therapy might be considered as a subsequent removing of the memory attractor of corresponding psychosomatic disorder - implying that process of the MRT therapy could be most deeply visualized as removal of the very information on corresponding psychosomatic disease (Jovanovic-Ignjatic and Rakovic 1999; Rakovic et al. 2000), cf. Fig 1.

Fig 1. Schematic presentation of the potential hypersurface of nonlocal selfconsistent macroscopic quantum potential in the acupuncture energy-state space (E, φ): 0 - basin of attraction of the ground (healthy) state φ; 1 and 2 - basins of attraction of the two excited (psychosomatically disordered) states φ and φ; (hundreds of them being in general). It should be pointed out that energy surface changes gradually during the MRT treatment, by decreasing the potential barriers ∆E1 and ∆E2 (and corresponding MRT sensory responses) of the potential wells 1 or 2, to be overcome in traversing to the 0 basin of attraction of the ground (healthy) state, when organism gradually recovers by further spontaneous approaching the healthy state φ (with poor MRT sensory response, as already being in the ground-state). Such a picture is very close to the associative neural networks ones in their energy-configuration spaces, and to pattern recognition as convergence of the neural networks to the bottoms of the potential hypersurfaces, being the attractors of neural networks memory patterns φ, φ, φ.
Such a similarity between the two approaches is presumably not a coincidence, as (real) mathematical formalism of the model of Hopfield's associative neural network (Hopfield 1982) is analogous (Peruš 1996; Peruš and Dey 2000) to (complex) mathematical formalism of Feynman's propagator version of the Schrodinger equation (Feynman and Hibbs 1965; Bjorken and Drell 1964), cf. Appendix I. This also supports the EM/ionic MW/ULF quantum-holographic function of the acupuncture system (like complex oscillatory holographic Hopfield-like neural network; see Peruš 1996; Peruš and Dey 2000), and its essential relation to (complex-valued quantum relativistic) consciousness, as strongly suggested from modeling of altered and transitional states of consciousness (Jovanovic-Ignjatic and Rakovic 1999; Rakovic et al. 2000; Rakovic 1994, 1995, 1997, 2000), cf. Appendix II (it should be added that the displaced part of ionic acupuncture structure in these states would have a function of an "optical" MW sensor, which can extrasensory perceive an environment, as reported by patients reanimated from clinical death; see Evans Wentz 1968; Monroe 1975; Nikovic et al. 1995). An additional support that acupuncture system is really related to consciousness is provided by novel meridian (psychoenergetic) therapies (with very fast removing of persistent phobias, allergies and other psychosomatic disorders; see Callahan and Callahan 1996; Callahan 2001; Mihajlović Slavinski 2000), whose simultaneous effects of visualization and tapping/touching acupuncture points might be interpreted as a "smearing" of memory attractors of the psychosomatic disorders; Callahan and Callahan 1996; Callahan 2001), through successive imposing new boundary conditions in the acupuncture energy-state space during visualizations of the psychosomatic problems (Rakovic and Mihajlović Slavinski 2004).

So, it can be said that beside brain’s hierarchical electrochemical neural network there exists acupuncture electromagnetic/ionic microwave ultralow-frequency-modulated quantum-holographic electrooptical neural network, with brainwaves being both the interface between them and ULF modulating factor of MW acupuncture network, implying also biophysical basis of psychosomatic disorders i.e. influence of psyche on the body; at the same time this presents explanation for the sensitivity of the organism on the influences of extremely weak external MW/ULF EM fields (Adey 1980), through MW/ULF EM induction within EM/ionic circulatory acupuncture system, thus modulating acupuncture currents by external EM fields, without any limitations by threshold potentials which do not even exist within gap junction electrical synapses of the acupuncture system.

Such brain/brainwaves/acupuncture system interface is continuously rewriting information from brain hierarchical neural network into acupuncture system, they being there superposed keeping their quantum coherence of the parallel processed subliminal ULF lower-frequency unconscious information within acupuncture EM/ionic MW-ULF-modulated quantum-holographic neural network (Rakovic 1994). The process of collapse of the wave function of macroscopic state of the acupuncture system, i.e. final quantum decoherence within the brain, might proceed through the same interface acupuncture system/brainwaves/brain. This is presumably realized through the brain’s frontolimbic process (Baars 1988) of the selection and amplification of the one out of many parallel processed subliminal ULF lower-frequency unconscious information (within the acupuncture system) toward ULF higher-frequency conscious thought in normal states of consciousness (within the brain), being subsequently rewritten into acupuncture system through the interface brain/brainwaves/acupuncture system, thus becoming amplified ULF higher-frequency normal conscious content (Rakovic et al. 2000; Rakovic 1994, 1995, 1997, 2000).
NONLOCAL MACROSCOPIC QUANTUM BIOPHYSICAL EFFECTS

Interactions of consciousness with microscopic and macroscopic environment

Consciousness is one of the oldest scientific problems, recognized already in ancient times, both in the civilizations of East and West. Although consciousness has been the central theme of philosophical essays for a long time from the very beginning of philosophical thought, or traditional esoteric practices of the East and West which have reached significant level in control of altered states of consciousness with significant philosophical and religious implications - the first scientific attempts to enlighten the phenomenon of consciousness appeared only in psychology of the second half of 19th century (through development of psychophysics and theories of personality), physics of the beginning of 20th century (through development of quantum mechanics and articulation of the problem of the so called wave function collapse, and the role of observer in this process), and computer sciences of the second part of 20th century (through development of artificial intelligence and the conception that the whole cognitive process can be reduced to a computer algorithm). However, due to scientific methodological difficulties the problem of consciousness has not gotten adequate treatment afterwards (corresponding multidisciplinary surveys on the problem of consciousness can be found in monographs of Baars (1988), Popper and Eccles (1977), Crick (1994), Penrose (1989, 1994, 1997), Tart (1972), as well as in our proceedings (Rakovic and Koruga 1996; Rakić et al. 1996)). Nevertheless, scientific investigation of consciousness underwent great renaissance in the last decade of 20th century, with a tendency to become the most significant scientific problem in a near future, being absolutely deserved owing to its unparallel potential implications in many fields (medicine, psychology, biology, physics, engineering, philosophy and religion), as recapitulated in the conclusion of the paper.


There are numerous macroquantum models of consciousness (some of them cited in tegmark (2000), whose aim is to investigate existence of the relevant brain/body degrees of freedom isolated enough to preserve their quantum coherence), and it is difficult to pretend on complete survey of these attempts. Therefore, in this paper we shall restrict ourselves on the approach and critique of the Copenhagen and von Neumann interpretations of quantum mechanics, and those attempts including ours to resolve manifestly open quantummechanical problems in the context of consciousness: (1) physical nature of the wave function nonlinear
collapse, (2) physical nature of the instantaneous action on distance of the wave function nonlocal collapse, and (3) existence of the relevant acupuncture macroscopic quantum degrees of freedom within the body (related to altered and transitional states of consciousness) isolated enough to preserve their quantum coherence.

The first attempts to treat consciousness strictly quantummechanically originate from von Neumann (1955), being supported by Wigner (1967) and lately by Stapp (1993, 2001): in contrast to Copenhagen interpretation of Bohr, Dirac, and Heisenberg (Bohr 1935; Dirac 1928; Heisenberg 1958), which insists on positivistic limitations of quantum theory only on the observer knowledge about quantum system (thus becoming essentially subjective and epistemologic theory, as the only reality of this theory is 'our knowledge') - von Neumann’s theory offers ontologically objective description of the reality and thus quantum framework for cosmological and biological evolution, including consciousness itself.

Besides, in the problem of quantum measurement i.e. collapse of the initial state of the quantum system in one of the possible probabilistic states of the system (when (linear) Schrodinger equation is a priori suspended and its boundary conditions are replaced by those corresponding to the collapsed state of the quantum system), in contrast to Copenhagen interpretation which treats it (quantum inconsistently) as an ad hoc process in the interaction of quantum system with classical measuring device - von Neumann’s theory treats the measuring device quantum consistently by postponing the collapse of the initial quantum state until the final interaction with observer’s consciousness in the chain quantum system/measuring device/observer, but also not explaining (nonlinear) nature of the collapse, with additional problem that ontological nonlocality of the collapse requests (relativistically inconsistent) instantaneous action on distance along space-like surfaces (which is the problem also implicitly transferred in the relativistic quantum field theory in spite of the relativistic invariance of the Tomonaga-Schwinger space-like surfaces; see Stapp 2001)!

It is obvious that in von Neumann’s ontological quantum theory, which consistently introduces phenomenon of consciousness, two open problems still exist: physical nature of the (nonlinear) collapse and instantaneous action on distance of the (nonlocal) collapse.

One possible solution of the problem of (nonlinear) collapse is proposed by Penrose (1989, 1994) in gravitationally induced reduction of the wave function, in which the gravitational field of measuring device included in the superposition of corresponding possible probabilistic states of the device implies the superposition of different space-time geometries, and when the geometries become sufficiently different (on the Planck-Wheeler scale ~ 10^{-35} m) this implies the break of standard quantum superposition of the state quantum system/measuring device (ill-defined in strictly separate space-time geometries) and Nature must choose between one of them and actually affects objective reduction of the wave function. (While regarding nonalgorithmic quantum-gravitational aspects of consciousness, Penrose tried to search for sufficiently isolated relevant macroscopic quantum degrees of freedom in microtubular citoskeletal structures of neurons (but not of acupuncture system!), which was undergone to severe critiques in Tegmark’s (2000) paper.)

According to Rakovic’s biophysical quantum-relativistic model of consciousness (Rakovic 1995, 1997, 2000; cf. Appendix II), the similar objective reduction of the wave function might have quantum-gravitational origin in space-time microscopic wormhole tunnels of highly noninertial microparticle interactions in quantum measurement-like situations (fully equivalent, according to
Einstein’s *principle of equivalence*, to strong gravitational fields - in which opening of wormholes is predicted; see Morris, Thorne, and Yurtsever 1988; Visser 1991; Thorne 1994, and references therein). The question how it is possible that these highly noninertial microparticle processes with inevitable relativistic generation of microparticles’ wormholes were not taken into account within quantum mechanics which is yet extremely accurate theory(!) - might be answered as they were(!), but implicitly within the *ad hoc* von Neumann’s projection postulate (von Neumann 1955) to account for quantum mechanical "wave packet collapse" in quantum measurement situations (implying also that *von Neumann’s ad hoc projection postulate is based on quantum gravitational phenomena*, being on deeper physical level than nonrelativistic quantum mechanical ones!). On the other hand, *nonlocality of collective consciousness* (Rakovic 1994, 1997), as a giant space-time associative neural network with distributed individual consciousnesses (related to bodily acupuncture EM/ionic microwave ultralowfrequently-modulated quantum-holographic neural networks (Jovanovic-Ignjatic and Rakovic 1999; Rakovic et al. 2000), mutually interacting quantum-gravitationally in transitional states of individual consciousnesses (Rakovic 1994, 1997, 2000)), might explain (apparently) *instantaneous action on distance* in (nonlinear) quantum-gravitationally induced and *(nonlocally) channeled collapse by collective consciousness* (this being also in accordance with nonlocal Princetone’s PEAR experiments of consciousness/machine interactions (Jahn and Dunne 1988), nonlocal Ditron’s experiments of consciousness/nonliving & living systems’ interactions (Tiller, Dibble, and Kohane 1999), nonlocal Novosibirsk’s experiments of consciousness/living & nonliving systems’ interactions (Kaznacheev and Trofimov 1992), as well as with nonlocal clinical Duke’s experiments on prayer-accelerated post-surgical patients’ recovery!

That quantum mechanically consistent approach to consciousness could really imply nonlocal properties of consciousness, might be supported by our considerations from two *additional directions* (Dugic, Rakovic, and Cirkovic 2000; Dugic, Cirkovic and Rakovic 2002): decoherence theory and cosmology.

*Theory of decoherence* seeks for physically consistent transition from quantum probabilistic indeterminism to classical reality, in the framework of quantum theory of measurement (Zurek 1991; Omnes 1994; Giulini et al. 1996), by treating a quantum system as *open* (but with assumption of universality of the linear Schrodinger equation, the problem of "wave packet collapse" remains unresolved within this approach too; see Rakovic and Dugic 2002). Dugic recently demonstrated the existence of necessary conditions for decoherence process (Dugic 1996, 1997a,b), giving rise in *macroscopic context* to wider physical picture which naturally encounters consciousness (cf. Appendix III): namely, *defining of the open quantum system (S) and its environment (E) which macroscopically includes consciousness as well, is the simultaneous process* - so that different macroscopic parts of the Universe as the open quantum system (S) are defined simultaneously with its macroscopic environment (E) which includes complementary consciousness (i.e. different macroscopic parts of the observed Universe define different complementary observing consciousness). In this way, within the context of universality of quantum mechanics *consciousness is only relative concept, nonlocally defined with all distant parts of the existing observed Universe* (although the reverse also holds true!).

This *relative metatheory of consciousness* is a part of *psycho-physical parallelism* which emphasizes holistic aspect of the whole Universe and naturally includes consciousness as its part (Wilber 1980; Rakovic and Koruga 1995; Hagelin 1987; Barrow and Tipler 1986). In their lucid
and instructive analysis of the collapse problem in quantum mechanics, Barrow and Tipler (1986) offer, apart from unattractive solipsism and Everett's "no collapse" theory (with bizarre branching of the system and environment into many copies with different states, continuing their independent existences; see Everett 1957), another three alternatives: either any being with consciousness can collapse the wave packet by observations, or a "community" of such beings can collectively collapse it, or there is some sort of "ultimate Observer" who is responsible for the collapse - the last two alternatives being natural candidates for incorporation within our relative metatheory of consciousness, thus supporting nonlocality of (collective) consciousness. Such a viewpoint that macroscopic parts of the Universe play central role in physical understanding of consciousness may not be so surprising, especially if one takes seriously numerous anthropic "coincidences" in both classical and quantum cosmology (Barrow and Tipler 1986; Carter 1990), with fine-tuning of the model physical parameters in the cosmological initial conditions close to the Big Bang singularity in order that life and consciousness be possible, as well as Cirkovic's arguments on relationship of quantum gravitation and transitional states of consciousness through their fundamental non-unitarity (cf. Appendix IV).

Conclusion
It is shown that investigations in the field of microwave resonance stimulation of the acupuncture system, as well as the research of consciousness interaction with microscopic and macroscopic environment - imply the existence of local and nonlocal macroscopic quantum biophysical effects, with great potential implications in many fields:

1. **medicine** (brain/consciousness relationship; brainwaves and brain functioning; acupuncture system and cognitive aspects of altered states of consciousness; relationship of nervous system and acupuncture system, and morphogenesis and psychosomatic disorders; local quantum holistic aspects of psychosomatics and wider application of the corresponding microwave resonance therapy on the level of acupuncture system; nonlocal quantum holistic aspects of psychosomatics and wider application of the corresponding transpersonal psychotherapy on the level of individual and collective consciousness);

2. **psychology** (mechanism and role of dreaming and meditation, as altered states of consciousness, in the integration of personality; mechanism of ascending of unconscious conflict to conscious level, and interaction of conscious and unconscious in different psychotherapeutic approaches; control of creativity and transpersonal phenomena in transitional states of consciousness, and psychotherapeutic implications for transpersonal clinical psychology);

3. **biology** (nonlocal interactions and adaptive mechanisms on the level of species; fundamental understanding of the significance of morality within human population);

4. **physics** (fundamental role of individual and collective consciousness in quantum theory of measurement; revealing of deep relationship of consciousness, space-time and structure of matter, in transitional states of individual and collective consciousness; role of transitional states of individual and collective consciousness in controlling exits of quantum-gravitational space-time tunnels);

5. **engineering** (exploitation of technology of quantum-gravitational tunnels and technology of transitional states of consciousness, for radical surpassing of space-time barriers in transport and communication; computers with artificial consciousness and creativity, on deeper quantum-gravitational principles);
(6) philosophy/religion (ontological nature of individual and collective consciousness; removal of the matter/spirit duality; post-mortem consciousness continuity; nonlocal transfer of individual loads on descendants in emotionally loaded transitional states of consciousness; origin of free will; fundamental significance of nonlocal holistic space-time reprogramming of collective consciousness in prayer for fellow-men, enemies, and the dead; renaissance of the behavior based on hesychastic spiritual principles of charity).

APPENDIX I

ON PARALLELS BETWEEN CLASSICAL AND QUANTUM
HOPFIELD-LIKE NEURAL NETWORKS

Hopfield’s classical neural networks (Hopfield 1982) have been extensively studied, simulated and used in cognitive neurosciences (Amit 1989; Peruš and Ecimovic 1998). However, it has also been shown recently that Hopfield’s classical neural network model is mathematically analogous to Feynman’s propagator version of the quantum theory (Feynman and Hibbs 1965). Hence, in this appendix the formal informational parallelism between classical and quantum Hopfield-like neural networks will be overviewed.

In the model of Hopfield’s classical neural network, emergent collective computation is regulated by minimization of the Hamiltonian energy function (Hopfield 1982)

\[
H = -\frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} J_{ij} q_i q_j = -\frac{1}{2} \sum_{i=1}^{N} \sum_{j=1}^{N} \sum_{k=1}^{P} J_{ik} q_i q_j
\]

(I.1)

where \(q_i\) is the actual collective activity of the \(i\)th neuron (out of \(N\) existing neurons in the network), while \(q_i^k\) is the contribution of the activity of the neuron \(i\) when taking part in encoding the \(k\)th memory pattern (out of \(P\) existing memory patterns in the neural network). The process of gradient-descent of this energy function is a result of a web of interactions between the system of neurons described by vector \(\mathbf{q}\) (with elements \(q_i\)) and the system of synaptic connections, described by the memory matrix \(J\) (with elements \(J_{ij}\)).

Thus, in the model of Hopfield classical neural network, Hebbian dynamic equation for neuronal activities

\[
q_i(t_2 = t_1 + \delta t) = \sum_{j=1}^{N} J_{ij} q_j(t_1) \quad \text{or} \quad q_\text{out}(t_2) = J q_\text{in}(t_1)
\]

(I.2)

and dynamic equation for synaptic connections (weights)
exhibit a joint classical parallel-distributed information processing system. This is one of the simplest algorithms useful for theoretical brain modeling (Amit 1989).

Equation (I.1) is global (variational) description, while system of equations (I.2-3) is local (interactional) description of the learning of input-data vectors \( \mathbf{q}_k \) in Hopfield's classical neural network. The corresponding neuronal activities can be inserted in the system of neurons \( \mathbf{q} \) iteratively, or can be put in the very beginning simultaneously into the Hebb memory matrix \( \mathbf{J} \) which contains all synaptic weights \( J_{ij} \).

Equations (I.2-3) can be rewritten in continuous form incorporating spatio-temporal description of neuronal and synaptic activities:

\[
\mathbf{q}_{out}(r_2,t_2) = \int \int f(r_2, r_1, t_2) \mathbf{q}_{in}(r_1, t_1) \, dr_1 dt_1
\]

\[
\mathbf{f}(r_2, r_1, t_2) = \sum_{k=1}^{P} \mathbf{q}^T(r_2) \mathbf{J}^T(r_1) \quad \text{or} \quad \mathbf{f}(r_2) = \sum_{k=1}^{P} \mathbf{q}^T(r_2) \mathbf{J}^T(r_1)
\]

The memory recall in Hopfield's classical neural network is done by input-output transformation \( \mathbf{q}_{out} = \mathbf{f} \mathbf{q}_{in} \) or in developed form

\[
\mathbf{q}_{out}(r_2,t_2 = t_1 + \delta t) = \int \mathbf{f}(r_2, r_1) \mathbf{q}_{in}(r_1, t_1) \, dr_1 = \int \left[ \sum_{k=1}^{P} \mathbf{q}^T(r_2) \mathbf{J}^T(r_1) \right] \mathbf{q}_{in}(r_1, t_1) \, dr_1
\]

From equation (I.6) it is obvious that if the input vector \( \mathbf{q}_{in} \) is most similar to some of the previously memorized vectors, say \( \mathbf{q}^l \) (and simultaneously almost orthogonal to all other memory vectors \( \mathbf{q}^k, k \neq l \)), then the output vector \( \mathbf{q}_{out} \) converges to the memory pattern-qua-attractor \( \mathbf{q}^l \), i.e. Hopfield's classical neural network associatively recognizes the vector \( \mathbf{q}^l \).

Haken has shown that introduction of biologically more plausible neuronal oscillatory activities gives richer dynamics of the neural network (Haken 1991), with Hopfield's classical neural net real-valued variables replaced by the complex-valued ones (similarly to quantum variables, although in contrast to thus conveniently modified classical formalism, the complex-valued quantum formalism is essential). A step further is done with quantum generalization of Hopfield's neural network: Sutherland's holographic neural network (Sutherland 1990) and, equivalent to it, Peruš's model of Hopfield-like quantum neural network (Peruš 1996; Peruš and Dey 2000). In this appendix we shall review Peruš's model, based on the direct mathematical correspondence between classical neural (left) and quantum variables (right) and corresponding Hopfield-like classical and quantum equations, respectively.
\[ q \Leftrightarrow \phi, \quad q^k \Leftrightarrow \phi^k, \quad J \Leftrightarrow G \]

\[(1.4) \Leftrightarrow (1.7), \quad (1.5) \Leftrightarrow (1.8), \quad (1.6) \Leftrightarrow (1.9)\]

The equations in pairs are mathematically equivalent, implying similar collective dynamics of the neural and quantum systems, in spite of different nature of the set of neurons (\( q \)) and their memory synaptic connections (\( J \)) in the neural network, on the one hand, and wave functions (\( \phi \)) and their propagator connections (\( G \)) in the quantum system, on the other hand.

So, in Peruš’s model of the Hopfield-like quantum neural network, dynamic equation for the wave function of the quantum state

\[
\phi_{\text{out}}(r_2, t_2) = \int \int G(r_2, r_1) \phi_{\text{in}}(r_1, t_1) \, dr_1 dt_1, \quad \text{or} \quad \phi_{\text{out}}(t_2) = G \phi_{\text{in}}(t_1)
\]

and dynamic equation for the propagator of the quantum system

\[
G(r_2, r_1) = \sum_{k=1}^{p} \phi^k(r_2) \phi^k(r_1)* \quad \text{or} \quad G(r_2, r_1) = \sum_{k=1}^{p} \phi^k(r_2) \phi^k(r_1)*
\]

exhibit a joint quantum parallel-distributed information processing system, where \( \phi^k \) are eigen wave functions of the quantum system. So \( \phi^k \) represents the memory state, and the propagator \( G \) constitutes the memory of thus informationally interpreted quantum system! (Actually, so defined propagator \( G \) is related to the usually used Green function propagator \( \overline{G} \), by equation \( G = -i\overline{G} \); see Feynman and Hibbs 1965; Bjorken and Drell 1964.)

The memory recall in Hopfield-like quantum neural network is done by input-output transformation \( \phi_{\text{out}} = G \phi_{\text{in}} \) or in developed form

\[
\phi_{\text{out}}(r_2, t_2) = \int \int G(r_2, r_1) \phi_{\text{in}}(r_1, t_1) \, dr_1 dt_1 = \int \int \left[ \sum_{k=1}^{p} \phi^k(r_2) \phi^k(r_1)* \right] \phi_{\text{in}}(r_1, t_1) \, dr_1 dt_1
\]

(i.9)

i.e. in the other form (where one can recognize the quantum superposition principle, i.e. the development of the wave function \( \phi_{\text{out}} \) over the wave functions \( \phi^k \))

\[
\phi_{\text{out}}(r, t) = \sum_{k=1}^{p} c^k(t) \phi^k(r) = \sum_{k=1}^{p} \int \left[ \phi^k(r)* \phi_{\text{in}}(r, t) \, dr \right] \phi^k(r)
\]

(i.9')
From equations (I.9) and (I.9') it is obvious that if the input wave function $\phi_{in}$ is most similar to some of the previously memorized wave function, say $\phi^l$ (and simultaneously almost orthogonal to all other memory eigen wave functions $\phi^k$, $k \neq l$), then the output wave function $\phi_{out}$ converges to the memory pattern-qua-attractor $\phi^l$, i.e. Hopfield-like quantum neural network associatively recognizes the eigen wave function $\phi^l$.

Or translated into orthodox language of the quantum physics (Bjorken and Drell 1964), in the above example the propagator $G$ represents the projector onto the wave subspace/state $\phi^l$, i.e. makes reduction (collapse) of the wave function $\phi_{in}$ of the quantum system into the eigen state $\phi^l$. Naturally, the collapse of the wave function of the quantum processor (not only of the hereby considered associative quantum memory) is also the final phase of the quantum computers as a network of quantum neurons (qubits; see Kitaev, Shen' and Vyali 1999; Bennett et al. 1993) - as well as the quantum decoherence within the brain (Tegmark 2000), presumably through the brain frontolimbic (Baars 1988; Popper and Eccles 1977) process of the selection and amplification of the one out of many (parallel processed subliminal ULF lowerfrequency) unconscious pieces of information toward (ULF higherfrequency) conscious thought in normal states of consciousness (Rakovic 2001).

Hopfield-like quantum neural networks are better than the classical ones because of the quantum phase differences which improve classical Hebbian amplitude coding (Amit 1989; Peruš and Ecimovic 1998). Namely, by insertion of the eigen wave functions $\phi^k$ in the form of modulated plane waves or wavelets (Peruš 1996),

$$\phi^k(r, t) = A^l(r, t) \ e^{i S^l(r, t) / \hbar}$$

the propagator of the quantum system (I.8) becomes

$$G(r_2, t_2, r_1, t_1) = \sum_{k=1}^{P} A_k(r_2, t_2) A^l_k(r_1, t_1) \ e^{i (S_k(r_2, t_2) - S^l_k(r_1, t_1)) / \hbar}$$

which describes the two-fold memory encoding: through the amplitude correlations, similarly to Hebbian rule in classical associative neural networks (Amit 1989; Peruš and Ecimovic 1998),
\[
\sum_{k=1}^{p} A_k (r_2, t_2) A_k (r_1, t_1)
\]

and through the phase differences, \( S_k = S_k (r_2, t_2) - S_k (r_1, t_1) \), similarly to holography (Sutherland 1990).

The correspondence of the informational-physical laws of neural and quantum physics, presented in this appendix, seems to represent only one of illustrations of the deep interrelations of the laws of Nature on different levels. It has also been shown recently (Ng 2001) that physical laws which describe simple clocks, simple computers, black holes, space-time foam, and holographic principle - are interrelated!

APPENDIX II

ON BIOPHYSICAL QUANTUM-RELATIVISTIC MODEL OF ALTERED AND Transitional States of Consciousness

According to Rakovic’s biophysical quantum-relativistic model of altered states of consciousness (Rakovic 1994, 1995, 1997, 2000), dreaming and similar hallucinate states are characteristics of the low-dielectric altered states of consciousness, with relativistic mixing of normally conscious and unconscious contents and extremely dilated subjective time base. Namely, according to this biophysical model, it is postulated that subjective reference system of consciousness is related to EM field of the ionic currents in nonhomogeneous parts of the bodily acupuncture ionic structures, and from the biophysical analysis of the models it follows that it must be displaced out of body in altered states of consciousness! On the other hand, additional macroscopic arguments imply that consciousness is related to EM field of the bodily acupuncture EM/ionic microwave ultralow-frequency-modulated quantum-holographic neural network, while analogy of the mathematical formalisms (Peruš 1997) of the models of Hopfield’s associative neural network and Feynman’s propagator version of Schrodinger equation implies that consciousness might be a property of the physical field itself - implying that giant nonlocal quantum neural network with distributed individual consciousness processing units behaves as a collective consciousness of Nature itself, as widely claimed by esoteric/religious traditions (Wilber 1980; Hagelin 1987; Vuićin 1995; Rakovic and Koruga 1995). This model might also provide additional route to the quantum-gravitational objective wave-packet reduction, and the role of consciousness in this process (Penrose 1989; Rakovic 1994).

Namely, this might be deeply connected with the role of collective consciousness (as a composite quantum state \( \Phi \) of all individual consciousness \( \phi^k \) (\( \Phi \approx \prod \phi^k \)) in quantum theory of measurement, where collective consciousness with its self-assembling \( \Phi \), \( \Phi_i \) (equivalent to convergence of quantum Feynman’s propagator to the state \( \Phi_i \)) contributes in instantaneous quantum channeling \( \Psi \Psi_i \) (reduction of the initial wave function \( \Psi \) into one of (possible)
probabilistic eigenstates $\Psi_i$) in quantum measurement-like situations. The very physical mechanism of the objective reduction in (nonlinear) collapse of the wave packet might have quantum-gravitational origin (similar to Penrose’s gravitation induced collapse; see Penrose 1989, 1994, 1997), in the space-time microscopic wormhole tunnels of highly noninertial microparticle’s interactions in quantum measurement-like situations (fully equivalent to extremely strong gravitational fields according to Einstein’s principle of equivalence, when relativistic generation of wormholes is predicted; Thorne 1994).

It should also be pointed out that the above collective consciousness’ self-assembling $\Phi_i$ in the quantum theory of measurement (on numerous prepared investigated quantum system $\Psi$) should be interpreted as purely probabilistic in Penrose’s gravitation-induced objective reduction of the wave packet (with relative frequency of their appearance given by quantum-mechanical probability $|a_i|^2$ of realization of corresponding microparticles’ eigenstates $\Psi_i$, where $\Phi_i = \sum_j a_j \phi_i | \psi_j$, $i = 1,2,3, ...$), depending not on the previous history of the repeatedly prepared quantum system. However, this might not be the case for biological individual consciousness’ self-assembling, being history-dependent deterministic one (resulting in history-ponderous more probable convergence of the macroscopic consciousness-related-acupuncture electromagnetic/ionic microwave ultralow-frequency-modulated oscillatory holographic Hopfield-like associative neural network to the deeper particular attractor in the potential hypersurface (e.g. Peruš and Dey 2000), or equivalently to more probable convergence of quantum Feynman’s propagator to the state $\phi^k$, fixedly determined by the more dominant state of individual consciousness), implying that strong preferences in individual futures might exist, governed by individual mental loads, as widely claimed in Eastern tradition (e.g. Wilber 1980), also presumably supported by contemporary mathematical discovery of the hidden Old Testament’s “Bible code”2 (Wittem, Rips, and Rosenberg 1994; Drosnin 1997); the same may apply to collective futures too, governed by interpersonal mental loads (Rakovic 1995, 2000). It should be also noted that these preferences in individual and collective futures might be anticipated in transitional states of consciousness which might be the basis of intuition, precognition and deep creative insights (Jahn 1982). What is really anticipated in transitional states of consciousness of individual consciousness might be the evolved state of cosmic collective consciousness ($t$) (to which our individual consciousness $\phi^k$ has access, being the constituting

---

2 A popular survey of mathematical discovery of this extraordinary code is given in the book: M. Drosnin, The Bible Code (Simon & Schuster, New York, 1997). The fascinating possibility that history of Civilization is preferably coded in The Old Testament revealed to Moses on the Mount Sinai 3000 years ago, might be interpreted as a consequence of the quantum-holographic nature of the cosmic collective consciousness (God!) and its every original manifestation (including The Old Testament, as well as every individual consciousness) – which still does not mean the strict determinism of the History by the existing state of collective consciousness, whose memory attractors could be reprogrammed by merciful prayer for the others thus removing interpersonal loads of the quantum-holographic neural network of collective consciousness – so leaving the room for free will and influence on future preferences.
part of cosmic collective consciousness), which is quantum-mechanically described by deterministic unitary evolution governed by Schrodinger equation.

However, it also seems that (non-Schrodinger governed) nonlocal individual-collective consciousness reassembling \( (\Phi \to \Phi_i) \) is possible, with direct influence on the collapse of the observed system \( (\Psi \to \Psi_i) \), which is supported by Princeton PEAR human/machine experiments (Jahn and Dunne 1988). In these experiments (even distant) human operators have been able solely by volition to influence the statistical behaviour of sophisticated machines with (otherwise) strictly random outputs, in a statistically repeatable effects (of the order of a few parts in ten thousand) - but individually not reproducible at any moment, which is a standard request in contemporary scientific experiments! All this can be accounted by intentional transitional transpersonal biological (non-Schrodinger governed) quantum-gravitational tunneling of the operator’s individual consciousness with mental addressing on the machine’s content of collective consciousness in the operator’s transitional states of consciousness (short and therefore not easily reproducible (Jahn 1982) highly noninertial processes of the out-of-body space-time quantum-gravitational mentally-channeled tunneling of operator’s part of the EM/ionic acupuncture system (Rakovic 1994, 1995)), thus channeling intentionally the operator/machine composite state of collective consciousness \( (\Phi \to \Phi_i) \), and automatically influencing the machine output \( (\Psi \to \Psi_i) \) in the non-Schrodinger quantum-gravitationally governed collapse-like process \( (\Phi \Psi \to \Phi_i \Psi_i) \). As a consequence one could really conjecture that consciousness might be essential property of Nature at different structural levels, macroscopic and microscopic, animate and inanimate, being presumably related to the unified field itself (Hagelin 1987).

That such nonlocal (non-Schrödinger governed) individual/collective consciousness reassembling \( (\Phi \to \Phi_i) \) is really possible, can be additionally supported by 1998’ Duke feasibility study conducted by the Duke University and Durham Veterans Affairs medical centers, in which angioplasty patients with acute coronary syndromes who were simultaneously prayed for by seven different religious sects around the world did 50 percent to 100 percent better during their hospital stay than patients who were not prayed for by these groups! This is in accordance with long-lasting empirical evidences of various Eastern and Western esoteric/religious traditions (Wilber 1980; Vujicin 1995; Vlahos 1998). It should be added, on this traditional line of evidences, that according to the consciousness-related-acupuncture electromagnetic/ionic microwave ultralowfrequency-modulated oscillatory holographic Hopfield-like associative neural network, esoteric/religious notions such as (Wilber 1980; Vlahos 1998; Rakovic 2000) psychic body (manomaya, lingasirira, manovijnana, ka, psyche, astral body, subtle body, soul, ...) and spiritual body (vijnanamaya, suksmasirira, manas, ba, thymos, noetic body, mental body, mind, ...) are biophysically inevitably associated with a partly displaceable (from the body, in altered and transitional states of consciousness) ionic acupuncture system, and an EM component of ionic currents embedded within it, respectively; also, the ionic condensations in the structured acupuncture system, with an EM component of ionic currents embedded within it, behave like...
distributed centers of consciousness (yogic chakras); finally, the ionic nature of the ethereal vitality (qi, prana, pneuma, bioenergy, ...) and ethereal body (related to nondifferentiated ions, essentially important for many biochemical processes within the body), might be noticed.

Finally, it should be pointed out that theoretical biophysical modeling of cognitive processes (Rakovic 2000, 2002) might have significant psychotherapeutic implications: (1) dreaming and meditation (as a prolonged altered state of consciousness) contribute to integration of conscious and unconscious contents around healthy associative memory ego-state, which results in growth of personality and alleviation of emotional conflicts; (2) autogenic training (as the most contemporary method of medical relaxation; see Rakovic 2001; Schultz 1951; Lindemann 1976; Cirkovic 1998) helps contextual messages to be associatively memorized at the subconscious level, from where they contribute to softening of undesired psychosomatic reactions on everyday stressful situations; however, for persons with strong psychological conflicts the main priority is reprogramming of their psychological conflicts and our modeling implies that this is possible in one of two possible ways: (3) deep psychotherapeutic practices (psychoanalytic, group, humanistic, gestalt, existential, body, transpersonal, expressive, hypno, integrative, experiential, ... orientation; see Milenkovic 1997; Jerotic 1998) oriented to recognition of the origin of unconscious conflict and its ascending to conscious level, thus diminishing corresponding unconscious conflicting associative memory state, which enables further integration of personality around healthy associative memory ego-state (Rakovic 2001, 2002; Poro 1990); (4) transpersonal Christian/religious technique (especially of hesychastic prayer; Vlahos 1998; Jerotic 1998) bears probably essential transpersonal aspect of psychological conflict and necessity of its simultaneous transpersonal reprogramming in all persons involved, contributing to its radical and final reprogramming at the level of spatio-temporal associative memory network of collective consciousness, which seems to be only possible through the prayer for others in transitional states of consciousness of the praying person (Rakovic 1994, 1997, 2000, 2001).

APPENDIX III

ON THE ROOTS OF RELATIVE METATHEORY OF CONSCIOUSNESS IN THE QUANTUM DECOHERENCE THEORY

The process (effect) of decoherence can be qualitatively defined as a physical process "induced" by environment E upon the quantum system S, which leads to effective, approximately classical-physical behavior of the quantum system. For many-particle systems, the effect is enormously quick (say of the order \( \tau \ll 10^{-23} \) s), and hence it is not surprising that this effect is observed only recently, in a very demanding experimental conditions.

The system S is open quantum system to which unitary (reversible Schrodinger) temporal evolution cannot be applied. However, for composite system S + E the universal validity of quantum mechanics is supposed, i.e. that it evolves in time according to Schrodinger equation, with Hamiltonian \( \hat{H} = \hat{H}_S + \hat{H}_E + \hat{H}_{\text{int}} \) which exists in the unitary operator of temporal evolution of the composite system: \( \hat{U}(t) = \exp\left(-\frac{2\pi i}{\hbar}\hat{H}t\right) = \hat{U}_{\text{int}}(t) \) (as the
interaction Hamiltonian \( \hat{H}_{\text{int}} \) is usually much greater than the "self-Hamiltonian" of the mutually noninteracting system \( \hat{H}_{S} \) and environment \( \hat{H}_{E} \)). Therefore, the problem of the decoherence theory is to calculate the "density matrix" of the system \( S \), defined as

\[
\hat{\rho}_{S} = tr_{E} \left\{ \hat{U}_{\text{int}}(t) \left| \Psi(t = 0) \right\rangle_{S},S,E} \left\langle \Psi(t = 0) \right| \hat{U}^{\ast}_{\text{int}} \right\}
\]  

(III.1)

where " \( tr_{E} \) " denotes integration over degrees of freedom of the environment, while \( \left\langle \Psi(t = 0) \right\rangle_{S},S,E} \) represents the initial state of the composite system \( S + E \) – alongside with finding orthonormalized basis \( \{ i_{S} \} \) in the Hilbert state space of the system \( S \), where at least approximate diagonal form of the density matrix (III.1) is obtained: \( \rho_{S_{0}} \equiv \sum_{i,i'} \left\langle i | \hat{\rho}_{S} | i' \right\rangle_{S} 0, i, i' \).

In a part of the literature the effect of decoherence is proclaimed as a very basis of boarder-line between the two quantum mechanical systems - the (open) system and its environment - in such a way that if there is no decoherence, then there is no boarder-line between the two systems mentioned above. Recent discovery of the existence of necessary conditions for decoherence (Dugić 1996, 1997) implies that quantum mechanics offers much more than one can (classically) comprehend and interpret. However, in the context of the above interpretation (according to which if there is no decoherence then there is no boarder-line between physical systems) the existence of necessary conditions poses the question: what about, mathematically possible, no-decoherence situations, when there is no possibility to establish boarder-line between the (open) quantum system and its (quantum) environment? At first sight, there is nothing to add here. However, it is not so; even more, a new "horizon" in investigation of the deeper fundamentals of the process of decoherence is opened, leading basically to some sort of metaphysical theory of consciousness. Some of the results will be shortly presented below.

Let the two (quantum) systems, \( S_{1} \) and \( E_{1} \), are given with their "degrees of freedom", alongside with their interaction which prevents the process of decoherence. Then the following reasoning appears possible and physically justified: let us introduce new coordinates, i.e. define two new systems (new system and its environment), \( S_{2} \) and \( E_{2} \), but in such a way that degrees of freedom of these systems represent (analytical) functions of degrees of freedom of the both "old" ones, \( S_{1} \) and \( E_{1} \), while the same interaction (i.e. the same interaction Hamiltonian), expressed in terms of new degrees of freedom, does not prevent decoherence. Then, the decoherence which is forbidden in the "old" composite system \( S_{1} \) and \( E_{1} \), now enables establishment of the boarder-line in the "new" composite system ("appeared" by redefining degrees of freedom in the same whole, \( S_{1} + E_{1} = S_{2} + E_{2} \))! I.e. the condition for decoherence simultaneously defines both the open system \( (S_{2}) \) and its environment \( (E_{2}) \). The "old" system and its environment, according to initial presumption, remain indistinguishable.

These transformations can be formally presented in the following way. Let the open system \( S_{1} \) is given with its degrees of freedom and (its canonically conjugated) generalized momenta,
(x_i, p_i), and analogously for its environment E_1, (X_j, P_j). Let the new (open) system and its environment, S_2 and E_2, are given with their variables, (ξ_m, π_m) and (Ξ_nΠ_n), respectively. Then the considered transformations have the form:

\[ \tilde{ξ}_m = \tilde{ξ}_m(x_i, p_i; X_j, P_j) \] (III.2)

\[ \tilde{π}_m = \tilde{π}_m(x_i, p_i; X_j, P_j) \]

for every variable (degree of freedom and generalized momentum) of the "new" system S_2 (and analogously) of its environment E_2). The Eq.(III.2) points out the following: the considered transformations (for instance, linear) interconnect degrees of freedom and generalized momenta of both ("old") system S_1 and ("old") environment E_1. So, the coordinates of the "new" system S_2 (and, simultaneously, of its environment E_2) are functions of the variables of both "old" systems, S_1 and E_1. In the quantum mechanical formalism, these transformations bear one very important consequence. Namely, in order that measurement of observables of the "old" systems might be possible, the measurement of observables of the "new" systems must be possible - simultaneously. But, this is not possible due to non-commuting degrees of freedom and momenta (of the "new" systems) and hence the transformation (III.2) is qualitatively different from the analogous classical transformations: if the interaction Hamiltonian is such that, in respect to degrees of freedom of the "new" systems, allows decoherence, then the decoherence concerns "new" systems, while (due to no-decoherence in respect to "old" systems) the "old" systems remain indistinguishable. Or more precisely: degrees of freedom of the "old" systems (S_1,E_1) are not defined by the condition of decoherence, while because of the uncertainty relations they cannot be measured even indirectly by virtue of measurement of observables of the "new" systems (S_2, E_2). This is the essence of the term "undistinguishable" for the "old" systems.

The generalization of this reasoning on the whole macroscopic systems of the physical Universe leads to an interesting conclusion. Namely, in the isolated macroscopic part of the Universe (MPU) the local transitions of the type S_1 + E_1 → S_2 + E_2 are forbidden, i.e. once established boarder-line (criterion for decoherence) cannot be changed locally, neither spontaneously nor by any external action. While eventual global transition, regarding MPU as a whole, is unobservable. The related physical argument is following: the physical basis of consciousness is, by presumption, many particle system which is subsystem of MPU. Hence the imagined global transition of the above type simultaneously concerns this physical system too, and therefore the basis for observation of the considered global transition disappears. In other words: the above mentioned transformations of the degrees of freedom redefine the (open) quantum systems, their environments, but also physical basis of consciousness, giving rise that, effectively, consciousness becomes a relative notion - defined by degrees of freedom of other systems (and their environments). Therefore, the considered global transition defines MPU as a whole, including definition of (physical basis) of consciousness. As different definitions of MPU are mutually exclusive (at least in the context of existing paradigms), it is possible to talk about relative metaphysical theory of consciousness, which bears some sort of (but not in the sense of von Neumann's theory) psycho-physical parallelism.
APPENDIX IV

ENTROPY AND NONUNITARITY IN THE PHYSICS OF BLACK HOLES AND CONSCIOUSNESS

There are at least two aspects of the contemporary physics of black holes and its application in cosmology which imply holistic nature of the universe, and have significance for any anthropic way of thinking. The first one is related to the fact that black holes, considered as classical objects with some quantum properties, have enormous number of degrees of freedom manifested through entropy of gravitating matter. This is represented by Bekenstein-Hawking formula (Bekenstein 1973; Hawking 1975):

\[ S_{BH} = \frac{k c^3 A}{G \hbar} \]  \hspace{1cm} (IV.1)

where \( A \) is the surface of the black hole's event horizon, and the rest are fundamental physical constants (\( k \) is the Boltzmann constant, \( c \) is the velocity of light in vacuum, \( G \) is the Newton gravitational constant, and \( \hbar \) is the Planck constant divided by \( \pi \)). It is obvious that the entropy of matter inside the event horizon is proportional to the surface of the horizon, while the physical problem of the (singular or nonsingular) state of the matter is not important from this point of view. In the simplest case of the spherically-symmetric nonrotating and electrically neutral black hole, the horizon is the sphere of the surface \( A = 4 \pi R^2 \), where \( R \) is the Schwartzshild (gravitation) radius given by \( R = \frac{2 G m}{c^2} \) (where \( m \) is the mass of the black hole). In combination with (IV.1) this gives

\[ S_{BH} = \frac{2 \pi G k}{\hbar c} m^2 \]  \hspace{1cm} (IV.2)

Now it is possible to calculate gravitational entropy of the matter inside our cosmological (particle) horizon, if it would collapse in a some way into giant black hole. This would be the state of maximal entropy, as the state of the matter within black hole, as shown by Bekenstein, is the most probable one from the viewpoint of the gravitational interaction. Any other state, like the one observed today with the matter mainly concentrated in galaxies, stars, planets, etc. with a small number of black holes, is a priori less probable. It should be noted, on the other hand, in the context of contemporary cosmological models, that situation when all the matter was within its gravitational radius actually took part in the past: all the matter inside our horizon was in the initial singularity of the Big Bang about 13.6 billion years ago.

By applying the Boltzmann formula \( S = k \ln W \), it is possible to estimate the statistical weight \( \langle W \rangle \) of the state characterized by the entropy \( S \) of the present universe (much less than maximal entropy from the Eq.(IV.2) estimated by Penrose (1989) as \( \sim 10^{123} \), in the units of the Boltzmann constant \( k \)). It is already qualitatively obvious that the presence of the logarithm in the Boltzmann equation implies that the present state is extremely less probable; its probability \( \langle W^{-1} \rangle \) is of the
order $\exp(-10^{123})$!!! Such a small number cannot be found in any other place in natural sciences. Hence this is most spectacular example of the "fine tuning", i.e. anthropic coincidences in cosmology. The former originates from the fact, realized by astrophysicists long ago, that very low gravitational entropy (sinonimous for relatively high uniformity of the early universe) is necessary for creation of the galaxies, which is the condition for existence of biological systems and intelligent observers. This conclusion was explicitly formulated by Collins and Hawking (1973) even before Bekenstein's papers and sudden increase of interest for the problem of the gravitational entropy.

The second aspect of the physics of black holes, of the great importance for problems of consciousness and intelligent observers, is the possibility of essential violation of determinism in semiclassical process of the evaporation of black holes (Hawking’s process). The hypothesis that transitional states of consciousness include inherently indeterministic evolution ("free will") can be potentially explained physically as a residuum of deeper physical processes that include nonunitarity. Such processes were seriously suggested by now only in the context of quantum gravitation, the Hawking process precisely. This argument deserves more detailed consideration, as it is less probable that this is merely coincidence. Rather, it presents an indirect support for the hypothesis of significant quantum gravitational role in the functioning of consciousness.

Hawking (1982) was the first to point on the possibility of nonunitary evolution of a physical system, as one of possible answers to the problem of the loss of information in the black holes. Namely, let us consider pure quantum state $|\psi\rangle$ which corresponds to the distribution of matter of the mass $m$ which collapses under the influence of self-gravitation. The density matrix of such state is given by $\rho = |\psi\rangle \langle \psi|$, with vanishing entropy $S = - \text{tr}(\rho \ln \rho)$. If $m$ is large enough, the matter will create the black hole inevitably. Afterwards, the black hole will evaporate slowly through the Hawking process, by emitting the black body radiation (which does not carry any nontrivial information). The semiclassical procedure used by Hawking in derivation of formula for the temperature of black hole will not be applicable when the mass of the evaporating black hole approaches to Planck mass, but what will happen with the information about the initial state still enclosed within the black hole? This is a puzzle of the loss of information within black holes (cf. for instance Giddings 1982).

The possibility proposed firstly by Hawking is that the black hole simply evaporates completely, so that information is lost irreversibly. This might be described as a fundamental unpredictability of black holes (and analogously of all other systems dominated by quantum gravitation). Although this idea remains as the simplest solution of the puzzle not contradicting any natural law, it raised a lot of discussions and controversies, as it necessarily implies fundamental non-unitarity of evolution of the complete system universe + black hole. Alternative solutions include possibility that information is still evaporated through the higher order corrections or that the Hawking evaporation is terminated when the mass of black hole becomes of the order of Planck's mass, leaving bellow the stable remnants encoding complete information on the initial state. However, these alternative solutions of the puzzle bear their deep problems, so the original Hawking’s idea is still considered as the most acceptable possibility. It should be pointed out that this (alongside with the collapse of the wave function) is by now the only phenomenon in the physical world where fundamental indeterminism can be manifested. Whether this is really manifested can be only confirmed by the future observable (on detection of the evaporating black holes) and theoretical (on development of the correct theory of the quantum gravitation, exact on
the Planck scale) works. In the framework of the idea - originating from Penrose - on the role of the future quantum theory of gravitation in explaining problem of consciousness, the possible causal relation of the indeterminism in consciousness and indeterminism in black holes might be an indirect confirmation of the idea that physical correlates of the mental states could be found only within some theory surpassing the contemporary physical theories.
REFERENCES


Andreyev YeA, Bely MU and Sit'ko SP. Manifestation of characteristic eigenfrequencies of human organism, Application for the Discovery to the Committee of Inventions and Discovery at the Council of Ministers of the USSR, No. 32-OT-10609, 22 May 1982, in Russian.


Dugic M. Contribution to the Foundation of the Theory of Decoherence in Nonrelativistic Quantum Mechanics, Ph.D. Thesis (Faculty of Science, University of Kragujevac, 1997b), in Serbian.


Jahn RJ and Dunne BJ. Margins of Reality (Harcourt Brace, New York, 1988), and many archival publications and technical reports by PEAR (Princeton Engineering Anomalies Research); see www.princeton.edu/~rdnelson/pear.html.

Jerotic V, Koruga Dj and Rakovic D, eds., Science – Religion – Society (Theological Faculty of Serbian Orthodox Church & Serbian Ministry of Religions, Belgrade, 2002), in Serbian.

Jerotic V. Individuation and (or) Deification (Ars Libri, Belgrade & Public University Library, Pristina, 1998), in Serbian; cf. especially Ch.7: Confession in Christian Churches and Psychotherapy.


Kaznacheev VP and Trosimov AV. Cosmic Consciousness of Humanity (Elendis-Progress, Tomsk, 1992).


Kitaev A, Shen’ A, and Vyalii M. Classical and Quantum Computations (MCNMO, Moscow, 1999), in Russian.


Leggett AJ. In Chance and Matter, Les Houches Summer School, 1986, Ch.VI.


Lindemann H. Autogenic Training (Prosijveta, Zagreb, 1976), Serbo-Croat translation from German.

Milenkovic S. Values of Contemporary Psychotherapy (Prometej, Novi Sad, 1997), in Serbian.

Ng YJ. From computation to black holes and space-time foam. Phys Rev Lett 2001; 86:2946-2949.
Nikolić V. Life after Life: Experiences of Orthodox Christians (Svetigora, Cetinje, 1995), in Serbian.
Portnov FG. Acupuncture Reflexotherapeutics (Zinatne, Riga, 1982), in Russian.
Rakovic D. Fundamentals of Biophysics (Grosknjiga, Belgrade, 1994), Chs. 5-6; in Serbian.


Schulte JH. Das Autogene Training (Thieme, Stuttgart, 1951), 7th ed.


Simko SP and Mkrtchian LN. Introduction to Quantum Medicine (Pattern, Kiev, 1994).


Vlahos J. Orthodox Psychotherapy: The Holy Fathers Science (Orthodox Missionary School of St. Alexander Nevskiy Church, Belgrade, 1998), Serbian translation from Greek.


Wilber K. The Atman Project (Quest, Wheaton, IL, 1980).


www.dukenews.duke.edu 1998, 9 Nov., News (Medical Center News Office, Duke University, NC, USA) - Results of this pilot study on 150 patients were intriguing enough to initiate wider investigations in several american medical centers; Overview of the previous similar studies can be found in the book of L. Dossey, Healing Words: The Power of Prayer and The Practice of Medicine (Harper Paperbacks, New York, 1993).

Xinnong C. Ed., Chinese Acupuncture and Moxibustion (Foreign Languages Press, Beijing, 1987).
