

HOPFIELD-LIKE QUANTUM ASSOCIATIVE NEURAL NETWORKS AND (QUANTUM)HOLISTIC PSYCHOSOMATIC IMPLICATIONS

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It is shown that any quantum system has a formal dynamical structure of Hopfield-like associative neural network. Besides, it is pointed out that investigations in the field of microwave resonance therapy of the acupuncture system, as well as research of the interactions of consciousness with microscopic and macroscopic environment - imply existence of local and nonlocal macroscopic quantum biophysical effects, with tremendous potential implications in the fields of medicine, psychology, biology, physics, engineering, and philosophy/religion.

Keywords—Quantum Hopfield-like associative neural networks, macroscopic quantum biophysical effects & holistic psychosomatics, microwave resonance therapy of acupuncture system, transpersonal psychotherapy of individual and collective consciousness.

I. INTRODUCTION

Hopfield's classical neural networks [1] have been intensely investigated and modeled for cognitive neurosciences [2]. It has been recently shown that Feynman's propagator version of *quantum theory* is analogous to Hopfield's model of classical associative neural network [3] - which is outlined in the first part of the paper - implying possibility to implement the model of quantum associative neural networks, both on software's level in classical digital computers and hardware's level in any of numerous physical media which can realize holography [4]. It should be also noted that quantum associative neural networks (working in the multi-dimensional Hilbert state space) ought to be distinguished from Deutch-based quantum computing algorithms with logic gates (working in two-dimensional Hilbert state space of qubits [5]).

On the other hand, recent investigations in the field of microwave resonance therapy of the acupuncture system, as well as research of the interactions of consciousness with microscopic and macroscopic environment - demonstrate existence of the local and nonlocal macroscopic biophysical effects [6] - implying that acupuncture system and consciousness are closely related quantum-holographic neural information systems, whose memory attractors determine (quantum)holistic psychosomatic disorders on the level of individual and collective consciousness [7], which is outlined in the second part of the paper.

II. ON HOPFIELD-LIKE QUANTUM ASSOCIATIVE NEURAL NETWORKS

In the model of *Hopfield's classical neural network*, emergent collective computation is either regulated by global (variational) minimization of the Hamiltonian energy function or by local (interactional) network learning in discrete or continuous forms (incorporating spatio-temporal description of neuronal and synaptic activities) [1,3]. Haken has shown that introduction of biologically more plausible *neuronal oscillatory activities* gives richer dynamics of the neural network [8], 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 was done with *quantum generalization* of Hopfield's classical neural network: Sutherland's *holographic neural network* [9] and, equivalent to it, Peruš's model of *Hopfield-like quantum associative neural network* [3].

In this section we shall outline *Peruš's model*, based on the direct mathematical correspondence between classical neural and quantum variables and corresponding Hopfield-like classical and quantum equations [3,6]: the mentioned pairs of equations 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 (ϕ) and their propagator connections (G) in the quantum system, on the other hand.

So, in Peruš's model of *Hopfield-like quantum associative neural network* [3], dynamic equation for the *wave function of quantum state* (in Feynman's quantummechanical path-integral formalism [10])

$$\begin{aligned}\phi_{out}(\mathbf{r}_2, t_2) &= \iint G(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) \phi_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 dt_1 \quad \text{or} \\ \phi_{out}(t_2) &= G \phi_{in}(t_1)\end{aligned}\quad (1)$$

and dynamic equation for the *propagator of the quantum system*

$$\begin{aligned}G(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) &= \sum_{k=1}^P \phi^k(\mathbf{r}_2, t_2) \phi^k(\mathbf{r}_1, t_1)^* \quad \text{or} \\ G(\mathbf{r}_2, \mathbf{r}_1) &= \sum_{k=1}^P \phi^k(\mathbf{r}_2) \phi^k(\mathbf{r}_1)^*\end{aligned}\quad (2)$$

exhibit a joint *quantum parallel-distributed information processing system*, where ϕ^k are eigenwave functions of the quantum system. So ϕ^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 \bar{G} , by equation $G = -i\bar{G}$ [10].)

The *memory recall* in Hopfield-like quantum associative neural network is done by input-output transformation $\phi_{out} = G \phi_{in}$, or in developed form

$$\begin{aligned} \phi_{out}(\mathbf{r}_2, t_2 = t_1 + \delta t) &= \int G(\mathbf{r}_2, \mathbf{r}_1) \phi_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 \\ &= \int \left[\sum_{k=1}^P \phi^k(\mathbf{r}_2) \phi^k(\mathbf{r}_1)^* \right] \phi_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 \end{aligned} \quad (3)$$

i.e. in the other form (where one can recognize the *quantum superposition principle*, i.e. the development of the wave function ϕ_{out} over the eigenwave functions ϕ^k)

$$\begin{aligned} \phi_{out}(\mathbf{r}, t) &= \sum_{k=1}^P c^k(t) \phi^k(\mathbf{r}) = \\ &= \sum_{k=1}^P \int \left[\phi^k(\mathbf{r})^* \phi_{in}(\mathbf{r}, t) d\mathbf{r} \right] \phi^k(\mathbf{r}) \end{aligned} \quad (3')$$

From equations (3) and (3') it is obvious that if the input wave function ϕ_{in} is most similar to some of the previously memorized eigenwave function, say ϕ^1 (and simultaneously almost orthogonal to all other memory eigenwave functions ϕ^k , $k \neq 1$), then the output wave function ϕ_{out} converges to the memory pattern-qua-attractor ϕ^1 , i.e. Hopfield-like quantum neural network *associatively recognizes* the eigenwave function ϕ^1 .

Or translated into orthodox language of the quantum physics [10], in the above example the propagator G represents the *projector* onto the wave subspace/state ϕ^1 , i.e. makes *reduction* (collapse) of the wave function ϕ_{in} of the quantum system into the eigen state ϕ^1 . 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 logic gates (qubits) [5] - as well as the *quantum decoherence within the brain* [11], presumably through the brain frontolimbic [12] process of the *selection and amplification* of the one out of many (parallelly processed subliminal ultralow (ULF) lower-frequency) unconscious pieces of information toward (ULF higherfrequency) conscious thought in *normal states of consciousness* [13].

Hopfield-like quantum associative neural networks are better than the classical ones because of the quantum phase differences which improve classical Hebbian amplitude coding [2]. Namely, by insertion of the eigen wave functions ϕ^k in the form of modulated plane waves or wavelets [3],

$$\phi^k(\mathbf{r}, t) = A_k(\mathbf{r}, t) e^{\frac{i}{\hbar} S_k(\mathbf{r}, t)} \quad (4)$$

the propagator of the quantum system (2) becomes $G(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) =$

$$= \sum_{k=1}^P A_k(\mathbf{r}_2, t_2) A_k(\mathbf{r}_1, t_1) e^{\frac{i}{\hbar} (S_k(\mathbf{r}_2, t_2) - S_k(\mathbf{r}_1, t_1))} \quad (5)$$

which describes the two-fold memory encoding: through the amplitude correlations, similarly to Hebbian rule in classical associative neural networks [2],

$$\sum_{k=1}^P A_k(\mathbf{r}_2, t_2) A_k(\mathbf{r}_1, t_1)$$

and through the phase differences, $\delta S_k = S_k(\mathbf{r}_2, t_2) - S_k(\mathbf{r}_1, t_1)$, similarly to holography [9].

It seems that hereby presented correspondence of the informational-physical laws of neural and quantum physics is only one of illustrations of the *deep interrelations of the laws of Nature* on different levels. It has also been shown recently [14] that physical laws which describe simple clocks, simple computers, black holes, space-time foam, and holographic principle - are interrelated!

III. MACROSCOPIC QUANTUM BIOPHYSICAL EFFECTS AS A BASIS OF HOLISTIC PSYCHOSOMATICS

In spite of significant financial and human resources engaged in biomedical investigations and health prophylaxis, human health is still jeopardized by numerous modern psychosomatic diseases, having its convenient ground in modern men exposed to everyday *stress*. Since conventional partial methods have failed to prevent and treat these health problems, new approaches are required which will include *holistic methods*, oriented in *healing a man as a whole* - but not a disease which is only a symptom of the disordered wholeness. Within the focus of these methods are the human *consciousness* and *acupuncture system*, mutually closely related in complementary medicine and transpersonal psychology - which is additionally supported by author's biophysical model of altered and transitional states of consciousness [6,7,15-17].

One of the main manifestations of consciousness is *free will*, whose physical place cannot be sought in the framework of (deterministic) classical physics, but only in the framework of (probabilistic) *quantum physics* [6,18-20]! Besides, other *holistic manifestations of consciousness*, like altered states of consciousness [21] and transitional states of consciousness [6,7,15,16], conscious/unconscious transitions and consciousness pervading body [22] - imply that *some manifestations of consciousness* must have *deeper quantum origin*, additionally supported by considerations on the roots of relative metatheory of consciousness in quantum decoherence and on the relationship between nonunitarity in quantum physics of black holes and in transitional states of consciousness [6,23].

As demonstrated by *quantum-coherent characteristics* of the Russian-Ukrainian school of microwave resonance therapy (MRT) [24,25] (highly resonant microwave (MW) sensory response of the disordered organism, biologically efficient nonthermal MW radiation of the extremely low intensity, and neglecting MW energy losses alongside acupuncture meridians), the *acupuncture system* is the only *macroscopic quantum system* in our body (while brain still seems not to be [11]). And as recent investigations show that any quantum system has formal mathematical structure of *quantum associative neural network* [3] – then *memory attractors of the acupuncture network* can be treated as *psychosomatic disorders* representing EM/MW (*quantum*)*holistic records* (which might be therefore removed only holistically, supported by an extreme efficiency of the MRT therapy that consequently erases the very information of the psychosomatic disorders, cf. Fig. 1) – which represents biophysical basis of (*quantum*)*holistic local psychosomatics* [6,7,17]!

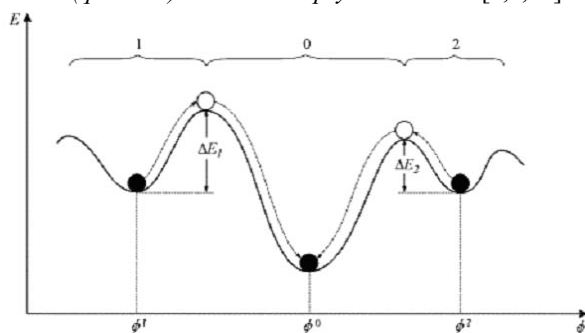


Fig. 1. Schematic presentation of the potential hypersurface of nonlocal selfconsistent macroscopic quantum potential in the acupuncture energy-state space (E, ϕ): 0 - basin of attraction of the ground (healthy) state ϕ^0 ; 1 and 2 - basins of attraction of the two excited (psychosomatically disordered) states ϕ^1 and ϕ^2 (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 ΔE_1 and ΔE_2 (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^0 (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^0, ϕ^1, ϕ^2 .

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 [26]), whose simultaneous effects of *visualization* and *tapping/touching acupuncture points* might be interpreted as a “*smearing*” of *memory attractors* of the psychosomatic disorders [26]), through successive imposing new boundary conditions in the acupuncture energy-state space during visualizations of the psychosomatic problems [27].

On the other hand, if *consciousness* has indeterministic characteristics (free will), it still must play essential role in

the *wave function quantum collapse* [6,18-20], the only indeterministic property of the quantum mechanics, which has itself *manifestly open problems* of the physical nature of *nonlinear collapse* and relativistically inconsistent instantaneous action on distance of the *nonlocal collapse* of the wave function [6,20].

One possible solution of the problem of (nonlinear) collapse is proposed by Penrose [28] 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 $\sim 10^{-35}$ 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 non-algorithmic quantum-gravitational aspects of consciousness [28], Penrose tried to search for sufficiently isolated relevant macroscopic quantum degrees of freedom in microtubular cytoskeletal structures of neurons (but not of acupuncture system!), which was undergone to severe critiques in Tegmark’s paper [11].)

According to author’s *biophysical quantum-relativistic model of consciousness* [6,7,15,16], 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 [29]). The question how is it 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 [18] 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* [6,7,15,16], being on deeper physical level than non-relativistic quantum mechanical ones!). On the other hand, *nonlocality of collective consciousness* [6,7,15-17], as a giant space-time associative neural network with distributed individual consciousnesses (related to human bodily acupuncture MW EM/ionic ULF-modulated quantum-holographic neural networks [6,7,17], mutually interacting quantum-gravitationally in transitional states of individual consciousnesses [6,7,15-17]), might explain (apparently) *instantaneous action on distance* in (nonlinear) quantum-gravitationally induced and (nonlocally) *channeled collapse by collective consciousness* [6] - this being also in accordance with nonlocal clinical *Duke’s experiments* on prayer-accelerated post-surgical patients’ recovery [30],¹ nonlocal *Princeton’s PEAR experiments* of

¹ Results of this feasibility study conducted by the Duke University and Durham Veterans Affairs medical centers

consciousness/machine interactions [31],² nonlocal *Ditron's experiments* of consciousness/nonliving & living systems' interactions [32], as well as with nonlocal *Novosibirsk's experiments* of consciousness/living & nonliving systems' interactions [33]! At the same time, analogy between mathematical formalisms of *Hopfield's associative neural network* [1] and *Feynman's propagator version of the Schrodinger equation* [10], presented in the first part of the paper, implies that *collective consciousness* is possible *ontological property of the physical field itself* [6,7,15-17,34] with various microquantum and macroquantum (both nonbiological and biological) excitations, which is widely spread thesis of *Eastern esoteric/religious traditions* [35].

The relict of these microscopic processes remained on the macroscopic level in *transitional states of individual consciousness* (as highly noninertial processes of the out-of-body spatio-temporal *quantum-gravitational mentally-channeled tunneling* of the part of acupuncture EM/ionic quantum-holographic neural network), presenting biophysical basis [6,7,14,16] of numerous *transpersonal communications* without space-time barriers [30-36] - where necessity of *mental addressing* on the target implies *ontological personal aspect of individual human consciousness*, which is widely spread thesis of *Christian religious tradition* [37], with the well known *post-mortem* implications.

Spontaneous transpersonal communications with information exchange in transitional states of individual consciousness have *negative effects*, as necessarily give rise to *global increase of psychosomatic loads* on the level of macroscopic quantum spatio-temporal network of *collective consciousness*³ - being the "motor of history".

- 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 - were intriguing enough to initiate wider investigations in several USA medical centers.

² The results of these experiments might be interpreted 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 operator's transitional states of consciousness, thus channeling intentionally the operator/machine composite state of collective consciousness ($\Phi \rightarrow \Phi_i$), and automatically influencing the machine output ($\Psi \rightarrow \Psi_i$) in the non-Schrodinger quantum-gravitationally governed collapse-like process ($\Phi\Psi = \sum_j a_j \Phi_j \Psi_j \rightarrow \Phi_i \Psi_i$).

³ This might be supported by so called Pulse Diagnostics based on 20 pulses in Tibetan Medicine, enabling precise diagnosis of psychosomatic disorders not only of the patient but also of his family members, friends, and enemies [38].

The *only phenomenon which decreases these loads is prayer for the others* emotionally connected with (relatives, enemies, deceased), mediated by powerful and purified EM/ionic archetype spiritual structures from religious traditions (removing in these interactions as a net effect the mutual conflicts of the two persons interacting through mediated prayer) - which represents the biophysical basis of (*quantum*)*holistic global psychosomatics* [6,7,15,16]! This strongly supports a *real biophysical nature* of the religious and other transpersonal experiences *related to transitional states of consciousness*, also explaining why these phenomena are *short lasting and poorly reproducible*, as well as why they are most easily *mentally controled* shortly prior the altered state of consciousness, like sleep [6,7,15,16] - which is in accordance with millenniums of empirical evidences of various religious/esoteric traditions of East and West [35,37], implying the *same biophysical basis* of these phenomena in all traditions, as the *cognitive apparatus* of the people of all traditions is the same [39]. This further implies a fundamental necessity for *religious education and behaviour* based on hesychastic spiritual moral principles of charity, *independently of differences between religious traditions and dogmatic systems* - as the *alternative is nonlocal transfer of individual loads on future generations* in emotionally loaded transitional states of individual consciousness (frequently with best intentions, love and concern for relatives, being thus *unconsciously mentally addressed on*).

All other methods of personality integration, like *meditation* (as *altered state of consciousness*, contributing to accelerated integration of conscious and unconscious levels of personality [6,7,15,16]) or *deep psychotherapeutic practices* (oriented to recognition of the origin of unconscious conflict and its ascending to conscious level [40]) - have holistic character of the *local psychosomatics and temporary effects on the level of individual consciousness* [6,7], as nonreprogrammed inter-personal conflicts within the others cause their (unconscious) *transpersonal reinducement* within the first person (thus working in vein on individual personality integration!) in transitional states of consciousness of these persons, thus *reinducing previous loads of collective consciousness*.

IV. CONCLUDING REMARKS

It is shown that according to Feynman's quantum mechanical propagator formalism any quantum system have formal structure of Hopfield-like associative neural network. The presented correspondence of the informational-physical laws of neural and quantum physics is only one of illustrations of the deep interrelations of the laws of Nature on different levels, implying a radical shifting of the frontiers of the parallel information processing on both microscopic and macroscopic levels - with tremendous potential physical and engineering implications.

Besides, it is pointed out that recent investigations in the field of microwave resonance therapy of the acupuncture system, as well as research of the interactions of consciousness with microscopic and macroscopic environment,

imply that acupuncture system and consciousness are closely related biophysical macroscopic quantum-holographic neural information systems, whose memory attractors determine (quantum)holistic psychosomatic disorders on the level of individual and collective consciousness - which might have extraordinary implications in psychosomatic medicine, transpersonal psychology, biology, and philosophy/religion.

REFERENCES

- [1] J. J. Hopfield, "Neural networks and physical systems with emergent collective computational abilities," *Proc. Natl. Acad. Sci. USA*, vol. 79, pp 2554-2558, 1982.
- [2] D. Amit, *Modeling Brain Functions: The World of Attractor Neural Nets*. Cambridge: Cambridge Univ. Press, 1989; M. Peruš and P. Ečimovič, "Memory and pattern recognition in associative neural networks," *Int. J. Appl. Sci. & Computat.*, vol. 4, pp. 283-310, 1998.
- [3] M. Peruš, "Neuro-quantum parallelism in mind-brain and computers," *Informatica*, vol. 20, pp. 173-183, 1996; M. Peruš and S. K. Dey, "Quantum systems can realize content-addressable associative memory," *Appl. Math. Lett.*, vol. 13, no. 8, pp. 31-36, 2000.
- [4] K. H. Pribram, ed., *Rethinking Neural Networks (Quantum Fields and Biological Data)*. Hillsdale, NJ: Lawrence Erlbaum A., 1993.
- [5] D. Deutch, "Quantum theory, the Church-Turing principle and the universal quantum computer," *Proc. R. Soc. A*, vol. 400, pp. 97-117, 1985; See also an overview web site by M. Dugić with wider reference list on Quantum Computation: <http://www.pmf.kg.ac.yu> and further link to <http://fizika.pmf.kg.ac.yu>.
- [6] D. Raković, M. Dugić, M. M. Ćirković, "Macroscopic quantum effects in biophysics," *Nauka Tehnika Bezbednost*, no. 1, pp. 161-178, 2001, in Serbian; Also published in *Proc. Satell. Symp. Quantum Epoch: 100 Years from the Discovery of Quantum Physics*, Banja Luka, Bosnia and Herzegovina: Academy of Sciences and Arts of Serbs Republic, 2001, in Serbian.
- [7] D. Raković, "Biophysical frontiers of holistic psychosomatics," in I. Kononenko, Ed., *Proc. 3rd Int. Multi-Conf. Information Society IS'2000, New Science of Consciousness*. Ljubljana, Slovenia: Information Society, 2000; D. Raković, "Transitional states of consciousness as a biophysical basis of transpersonal transcendental phenomena," *Int. J. Appl. Sci. & Computat.*, vol. 7, pp. 174-187, 2000; D. Raković, "Biophysical bases and frontiers of (quantum)holistic psychosomatics," in V. Jerotić, Dj. Koruga, and D. Raković, Eds., *Science - Religion - Society*. Belgrade: Theological Faculty of Serbian Orthodox Church & Serbian Ministry of Religions, 2002, in press, in Serbian.
- [8] H. Haken, *Synergetic Computers and Cognition: A Top-Down Approach to Neural Nets*. Berlin: Springer, 1991.
- [9] J. G. Sutherland, "Holographic model of memory, learning and expression," *Int. J. Neural. Sys.*, vol. 1, pp. 256-267, 1990.
- [10] J. D. Bjorken and S. D. Drell, *Relativistic Quantum Mechanics*, vol. 1/ *Relativistic Quantum Fields*, vol. 2. New York: McGraw-Hill, 1964/1965; R. P. Feynman and A. R. Hibbs, *Quantum Mechanics and Path Integrals*. New York: McGraw-Hill, 1965.
- [11] M. Tegmark, "Importance of quantum decoherence in brain processes," *Phys. Rev. E*, vol. 61, pp. 4194-4206, 2000.
- [12] K. R. Poper and J. C. Eccles, *The Self and Its Brain*. Berlin: Springer, 1977; B. J. Baars, *A Cognitive Theory of Consciousness*. Cambridge, MA: Cambridge Univ. Press, 1988.
- [13] D. Raković, "Hierarchical neural networks and brainwaves: Towards a theory of consciousness," in Lj. Rakić, G. Kostopoulos, D. Raković, and Dj. Koruga, Eds., *Brain and Consciousness: Proc. ECPD Workshop*. Belgrade: ECPD, 1997; D. Raković, "On brain's neural networks and brainwaves modeling: Contextual learning and psychotherapeutic implications," in B. Lithgow and I. Cosic, Eds., *Biomedical Research in 2001: 2nd Proc. IEEE/EMBS (Vic)*. Melbourne, Australia: IEEE/EMBS Victorian Chapter, 2001.
- [14] Y. J. Ng, "From computation to black holes and space-time foam," *Phys. Rev. Lett.*, vol. 86, pp. 2946-2949, 2001.
- [15] D. Raković, *Fundamentals of Biophysics*. Belgrade: Grosknjiga, 1994, 1995, chs. 5-6, in Serbian; Group of authors, *Anti-Stress Holistic Handbook: With Fundamentals of Acupuncture, Microwave Resonance Therapy, Relaxation Massage, Aeroionotherapy, Autogenic Training, and Consciousness*. Belgrade: IASC, 1999, in Serbian.
- [16] D. Raković, "Neural networks, brainwaves, and ionic structures: Acupuncture vs. altered states of consciousness," *Acup. & Electro-Therap. Res., Int. J.*, vol. 16, pp. 89-99, 1991; D. Raković, "Brainwaves, neural networks, and ionic structures: Biophysical model for altered states in consciousness," in D. Raković and Dj. Koruga, Eds., *Consciousness: Scientific Challenge of the 21st Century*. Belgrade: ECPD, 1995, 1996; D. Raković, "Prospects for conscious brain-like computers: Biophysical arguments," *Informatica (Special Issue on Consciousness as Informational Phenomenalism)*, vol. 21, pp. 507-516, 1997.
- [17] Z. Jovanović-Ignjatić and D. Raković, "A review of current research in microwave resonance therapy: Novel opportunities in medical treatment," *Acup. & Electro-Therap. Res., The Int. J.*, vol. 24, pp. 105-125, 1999; D. Raković, Z. Jovanović-Ignjatić, D. Radenović, M. Tomašević, E. Jovanov, V. Radivojević, Ž. Martinović, P. Šuković, M. Car, and L. Škarić, "An overview of microwave resonance therapy and EEG correlates of microwave resonance relaxation and other consciousness altering techniques," *Electro- and Magnetobiology*, vol. 19, pp. 193-220, 2000; D.

- Raković, "Biophysical bases of the acupuncture and microwave resonance stimulation," *Physics of the Alive*, vol. 9, pp. 23-34, 2001.
- [18] J. von Neumann, *Mathematical Foundations of Quantum Mechanics*. Princeton, NJ: Princeton Univ. Press, 1955.
- [19] E. Wigner, "Remarks on the mind-body problem," in *Symmetries and Reflections*. Bloomington, IN: Indiana Univ. Press, 1967.
- [20] H. P. Stapp, "Quantum theory and the role of mind in nature," *Found. Phys.* vol. 31, pp. 1465-1499, 2001; H. Stapp, *Mind, Matter, and Quantum Mechanics*. New York & Berlin: Springer, 1993.
- [21] C. Tart, Ed., *Altered States of Consciousness*. New York: Academic Press, 1972.
- [22] A. Shimony, in R. Penrose and A. Shimony, N. Cartwright and S. Hawking, Eds., *The Large, the Small and the Human Mind*. Cambridge: Cambridge Univ. Press, 1995.
- [23] M. Dugić, M. M. Ćirković, and D. Raković, "On a possible physical metatheory of consciousness," *Open Systems and Information Dynamics*, vol. 9, pp. 153-166, 2002.
- [24] N. D. Devyatkov, "Influence of the millimeter wavelength range electromagnetic radiation upon biological objects," *Soviet Physics - Uspekhi*, vol. 110, pp. 452-454, 1973; See also pp. 455-469 in this volume; N. D. Devyatkov and O. Betskii, Eds., *Biological Aspects of Low Intensity Millimeter Waves*. Moscow, Russia: Seven Plus, 1994.
- [25] S. P. Sit'ko, Ye. A. Andreyev, and I. S. Dobronravova, "The whole as a result of self-organization," *J. Biol. Phys.*, vol. 16, pp. 71-73, 1988; S. P. Sit'ko and V. V. Gizhko, "Towards a quantum physics of the living state," *J. Biol. Phys.*, vol. 18, pp. 1-10, 1991; S. P. Sit'ko and L. N. Mkrtchian, *Introduction to Quantum Medicine*. Kiev, Ukraina: Pattern, 1994.
- [26] R. J. Callahan and J. Callahan, *Thought Field Therapy and Trauma: Treatment and Theory*. Indian Wells, CA: Private Edition, 1996; R. J. Callahan, "The impact of thought field therapy on heart rate variability (HRV)," *J. Clin. Psychol.*, Oct. 2001 (see www.interscience.wiley.com); Ž. Mihajlović Slavinski, *PEAT and Neutralization of Primeval Polarities* (Belgrade, 2000), in Serbian.
- [27] D. Raković and Ž. Mihajlović Slavinski, in preparation (2002).
- [28] R. Penrose, *The Emperor's New Mind*. New York: Oxford Univ. Press, 1989; R. Penrose, *Shadows of the Mind: A Search for the Missing Science of Consciousness*. Oxford, England: Oxford Univ. Press, 1994.
- [29] M. S. Morris, K. S. Thorne, and U. Yurtsever, Wormholes, time machines, and the weak energy condition, *Phys. Rev. Lett.*, vol. 61, pp. 1446-1449, 1988; K. S. Thorne, *Black Holes and Time Warps: Einstein's Outrageous Legacy*. London: Picador, 1994, and references therein.
- [30] www.dukenews.duke.edu 1998, 9 Nov., *News*, Duke, NC: Duke University, Medical Center News Office; 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*. New York: Harper Paperbacks, 1993.
- [31] R. G. Jahn, "The persistent paradox of psychic phenomena: An engineering perspective," *Proc. IEEE*, vol. 70, pp. 136-170, 1982; R. J. Jahn and B. J. Dunne, *Margins of Reality*. New York: Harcourt Brace, 1988, and many archival publications and technical reports by PEAR (Princeton Engineering Anomalies Research); see www.princeton.edu/~rdnelson/pear.html.
- [32] W. A. Tiller, W. E. Dibble, jr., and M. J. Kohane, "Exploring robust interactions between human intention and inanimate/animate systems," *Ditron preprint* (presented at *Int. Conf. Toward a Science of Consciousness - Fundamental Approaches*, Tokyo, Japan: UN Univ., May 1999).
- [33] V. P. Kaznacheev and A. V. Trofimov, *Cosmic Consciousness of Humanity*. Tomsk, Russia: Elendis-Progress, 1992), and references therein.
- [34] J. S. Hagelin, "Is consciousness the unified field? A field theorist's perspective," *Modern Sci. & Vedic Sci.*, vol. 1, pp. 29-88, 1987, and references therein.
- [35] K. Wilber, *The Atman Project*. Wheaton, IL: Quest, 1980.
- [36] R. Monroe, *Journeys Out of the Body*. Garden City, NY: Doubleday, 1971; R. A. Moody, jr., *Life after Life*. New York: Bantam, 1975; W. Evans Wentz, *The Tibetan Book of the Dead*. London: Oxford Univ. Press, 1968; V. Nikčević, Ed., *Life after Life: Experiences of Orthodox Christians*. Cetinje: Svetigora, 1995, in Serbian.
- [37] J. Vlahos, *Orthodox Psychotherapy: The Holy Fathers Science*. Belgrade: Orthodox Missionary School of St. Alexander Nevskiy Church, 1998, Serbian translation from Greek.
- [38] S. Petrović, *Tibetan Medicine*. Belgrade: Narodna knjiga - Alfa, 2000, in Serbian.
- [39] M. Eljajade, *Guide through World Religions*. Belgrade: Narodna knjiga - Alfa, 1996, Serbian translation from English.
- [40] S. Milenković, *Values of Contemporary Psychotherapy*. Novi Sad: Prometej, 1997, in Serbian.