Informatica Vol. 26, No. 1 (2002), pp. 85-90

A CRITICAL NOTE ON THE ROLE OF THE QUANTUM MECHANICAL "COLLAPSE" IN QUANTUM MODELING OF CONSCIOUSNESS

Dejan Rakovic[1, 3] and Miroljub Dugic[2, 3]

[1] Faculty of Electrical Engeneering, P.O.Box 35-54, 11120 Belgrade, Yugoslavia
E-mail: rakovic@net.yu

[2] Faculty of Science, Department of Physics, P.O.Box 60, 34 000 Kragujevac, Yugoslavia
E-mail: dugic@knez.uis.kg.ac.yu

[3] International Anti-Stress Center (IASC), Smiljaniceva 11/III/7, 11000 Belgrade, Yugoslavia
E-mail: info@iasc-bg.org.yu

Abstract: We give a brief account on the existing strategies in quantum-mechanical approaching the problem of consciousness. To a list of distinguished approaches we add the next plausible notion: when treated quantum-mechanically, consciousness should be modeled as an open quantum system. This notion is tightly connected to the von Neumann's "collapse" ("wave packet reduction"). Here we strongly emphasize that the problem of the "collapse" cannot be resolved within the quantum mechanics of open quantum systems (or: decoherence theory). Some clues in this regard are briefly outlined.

Key words: Consciousness, quantum modeling, neural networks, quantum measurement, "collapse", open quantum systems.

1. Introduction

The complex subject of *consciousness* does not stop drawing attention of the general scientific community. Particularly, it was suggested that some manifestations of consciousness might have a deeper physical origin, which requires the use of the laws and methods of *quantum physics*. Therefore, the problem of consciousness partially becomes a matter of investigation within, e.g., the quantum-mechanical formalism *and* interpretation, still with the stringent "constraints" coming from the phenomenological data.

The purpose of this paper is to put forward some critical remarks concerning the above distinguished approach to the problem of consciousness, with an emphasis on the role of the quantum-mechanical "wave packet collapse (reduction)" (further: "collapse").

In Section 2 we briefly and critically overview the arguments concerning the quantum-mechanical nature of consciousness, adding a new point in this concern. In Section 3 we critically discuss the role of the quantum-mechanical "collapse" within the quantum theory of consciousness. Section 4 is discussion and conclusion.

2. Some critical remarks on the quantum nature of consciousness

There are significant efforts in establishing the quantum (e.g., quantum-mechanical) nature of consciousness. It seems convenient here to give a brief overview of some of the existing results and statements, still without ambition to be exhaustive. (Note: the main criterion for making the list below, is that the authors more-or-less explicitly argue for the use of quantum formalism(s) in modeling of consciousness).

The brilliant brief review-article by Jibu and Yasue [10] shares belief with the *"reductionists"*, who (sometimes noncritically) assert that the physical laws of the complex (many-particle) systems can be traced back to the fundamental laws of quantum physics. Originally, the above mentioned "reductionism" is due to Ricciardi and Umezawa [19], and is stated as [10]: "deeper understanding of natural phenomena [can be obtained] only after having an adequate grasp of the theories derived from the first principles of physics"[1].

The experience with the Microwave Resonant Therapy (MRT), as a medical cure, points out the rather intriguing results: (1) sharply-resonant sensory response of the disordered organism to small changes of the external microwave (MW) radiation frequency ($0.01-0.1\%$); (2) low-intensity (down to 10^{-9} W/cm^2) and low-energy (down to 10^{-4} eV) of the biologically efficient MW radiation rather below the thermal noise effect ($\sim 10^2$ W/cm^2 and $\sim 10^{-2}$ eV); and (3) negligible MW energy losses during propagation for significant distances down acupuncture meridians (~ 1m) from the exposed acupuncture points. Such *quantum-like* characteristics of MRT inspired Sit'ko [20] and coworkers to *propose a quantum physics of alive*. In the framework of their model, acupuncture meridians might be related to eigenfrequencies and spatio-temporal eigenwaves of every biological quantum system, being its individual characteristic. On these grounds Rakovic et al [17] suggest that healthy condition might be considered as an absolute minimum (ground state) of the nonlocal self-consistent macroscopic quantum potential of the organism. Some disorders of an acupuncture system are supposed to correspond to higher minimums of the (spatio-temporally changeable) potential hypersurface in energy-configuration space. This possibly explains the higher 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 - this picture being very close to those of *associative neural networks* in their energy-configuration spaces, and to pattern recognition as convergence of the neural-network memory patterns.

As Peruš [16] points out, the classical neural-network model of brain activities *does not prove sufficient* for reaching the subtlety and unity of consciousness. Besides, he gives some details with regard to *formal analogy* between the "quantum processes" in Feynman's propagator version of quantum mechanics and "neural-network processes" of Hopfield's oscillatory holographic neural network (cf. Section 6 therein), particularly emphasizing the "uncertainty analogy" - i.e., analogy between the quantum uncertainty, and the uncertainty inherent to the neural-network processing. These similarities of the quantum and neural network pictures might not be only formal, supporting the EM/ionic holographic microwave/ultralowfrequency (MW/ULF) *quantum neural-network-like* function of the acupuncture system, and its essential relation to (complex-valued quantum relativistic) *consciousness* - as strongly suggested from Rakovic's [18] modeling of altered and transitional states of consciousness.

The lucid and illuminating analysis by Penrose [15], concerning the noncomputable nature of human (mathematical) understanding points to the, so-called, "objective reduction (collapse) - OR", as a possible *physical basis* of human faculty of understanding. Actually, in a long run of argumentation (and speculation), Penrose meets the problem (: where to look for noncomputable physical law(s)), and *makes a guess* in this concern (appointing OR), which is suggested to fall within the quantum gravitation theories.

The quantum holography modeling of the "brain/mind" by Marcer and Schempp [13] bears *positivistic attitude*. Actually, they point to some advantages of the quantum-mechanical treatment of some specific subjects of consciousness. Among else, there are the next "subjects": both digital and analogue[2] computation, the problem of unity of consciousness, and that some *non-local "anomalies" of consciousness* (such as the, so-called, altered states of consciousness) cannot be

[1] Still, although it is strongly suggested by Jibu and Yasue that " 'popular quantum mechanics' ... never provides us with a proper scientific understanding of the deep question 'What is consciousness?' but with a fatal misunderstanding", the formal part of the model of "quantum brain dynamics" *really is quantum mechanical*! Actually, cf. Appendix A therein, the "Quantum Electrodynamics of Ordered Water" is *completely* formulated within the *Hamiltonian formalism*, and really falls within the methodology of *modern quantum mechanics of open systems* - as it can be directly seen by comparing to the papers of, e.g., Zurek [24-26], and especially Dugic [6]

[2] Here, by "analogue computation" we mean the, so-called, "quantum computing", which is really a computational process which *simulates quantum mechanical dynamics* of the actual system.

properly physically explained, *unless* - as advocated by Rakovic [18] - they are somehow founded on the *quantum-mechanical nonlocality*[3].

It is worth stressing that, relative to the formulation of quantum mechanics, the above distinguished approaches to quantum nature of consciousness, bear *plausibility*. Actually, the venture of quantum physics begins with inability for obtaining the classical-physics explanations of some experimental data - which is widely known as the "physical basis of quantum mechanics". On the other hand, *still, we do not deal with either complete phenomenology, or classical-physics theory of consciousness*. Therefore, from the purely methodological point of view, the quantum nature of consciousness appears just as a *working hypothesis* in the physical approach to consciousness.

On this line of thought and plausibility, and this is the main point of this Section, we add (to the above list) the point given below, still not fully distinguished in the literature. First, we point to the following characteristic of the neural *network models* of the brain-activities (which appear as *ultimate physical origin* of consciousness): it is not entirely clear what should (or even could) be the state (and dynamics) of an isolated neural network, i.e., the dynamics of a neural network is *substantially* determined[4] by external stimulation (cf., e.g., Ref. [10, 16]).

When expressed in physical terms, the above characteristic of neural networks reads as follows: the physical behaviour (i.e. dynamics) - but, probably, even existence (cf. Jibu and Yasue [10]) - of a neural network is substantially determined by interaction (cf. "stimulation") with its environment (cf. "external"[5]). And this justifies the next suggestion: *if treated quantum-mechanically, the neural networks should be modelled as open quantum systems*.

Within quantum mechanics of open quantum systems, the above remark links the subject of consciousness with the subjects of "decoherence" [1, 11, 24-26, 5, 6], the "collapse" [2, 4, 8, 12, 15-18, 23-25], and with the (quantum) "chaos" [2, 8, 26]. Here we shall only discuss the second issue - as it is stated in title of this paper.

We conclude this Section by noting that, for some phenomenological data, and according to some physical reasoning, it seems plausible to *adopt the hypothesis* that consciousness, i.e., some of its physical manifestations, might have the quantum-mechanical origin. As a new, nontrivial point of our argumentation in this respect appears *suggestion* that, whatever it might be, a physical model of consciousness should be considered as *an open quantum system*.

3. The problem of the "collapse" unresolved

As it was distinguished in Introduction: once adopted, the hypothesis of quantum-mechanical nature (or physical basis) of consciousness implies that further investigation falls into the "machinery" of the quantum-mechanical formalism. This way naturally comes to scope the problem of the "collapse", which can be considered as virtually independent of a (quantum-mechanical) model of physical system (here: brain activities and, in a long run, of consciousness); i.e., the "collapse" is a general issue of quantum mechanics[6].

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[3] By (quantum) non-locality we mean non-locality as it is defined within the famous "EPR effect", and which is a straightforward consequence (which postulated the "collapse") of the quantum correlations (cf., e.g, the r.h.s of (I.1)).

[4] Whilst this fact is well known from the engeneering perspective, this is not necessarily the case in the physical considerations. Actually, it is a general feature of the physical modeling to have a well-defined isolated system, which may interact with another (also previously well-defined isolated) system.

[5] Here, "external" should not be literally understood. For instance, for a *sub*network, the other subnetworks of the same, whole network, might appear "external". For this reason, in analogous physical situations, there appear the concepts (the terms - cf. e.g., Omnés [14]) "external environment", and "internal environment", only requireing that "environment" is sufficiently "big" (i.e., that the limit $N \to \infty$ is legitimate; N is the number of particles constituting the "environment").

[6] It is worth stressing that the issue of the “collapse” cannot be circumvented even in the alternative quantum measurement theories. And this is due to the fact that all the theories, at least implicitly, employ some conditions coming from the assumption that the “quantum object” is an open quantum system.

Still, with respect to the told in Section 2, one should note that the "route" for approaching the "collapse" is, at least, two-fold. On one side, one may consider the "collapse" as an *emergent property* of the quantum systems, which can be formally "settled down" by the famous "projection postulate" [23]. On the other side, in Section 2 it was argued that the physical model of consciousness should be considered as an open quantum system - which is substantially different physical situation; let us briefly justify this notion.

As it is well known, the "projection postulate" appears as an *ad hoc* rule for obtaining (reproducing) the results of the generalized (and simplified) "scheme" of the (idealized) quantum measurement situations. This characteristic of the "projection postulate" is the main reason for extensive search for the more physical solution of the problem at hand. As a result of these efforts appears the, so-called, quantum mechanics of open systems [1, 2, 5-8, 11, 12, 14, 24-26]. And sometimes (noncritically) a statement is adopted, according to which the "collapse" naturally follows as a consequence of interaction of a quantum system with its environment.

Unfortunatelly, and this is the very point of this Section, this statement cannot be considered physically correct. More precisely: *the very openness of a quantum system does not prove sufficient for obtaining the "collapse" as an objective physical process*; in terms of the quantum measurement theory [12, 25]: the openness of a quantum system sharpens, but *does not resolve* the quantum measurement problem. Those readers interested in the "technical" details should refer to Appendix I below (and references therein), in which it is implicit that the problem of "collapse" can be traced back to the (von Neumann's [23]) hypothesis of the universal validity of the Schrödinger law. Since, on the other side, this hypothesis seems generally adopted (except in the theory of Dugic [7]), and particularly in the quantum modeling of consciousness [10, 13, 16, 18], one may conclude that the "collapse" does not appear more useful in quantum modeling of consciousness, than it is the case within the quantum measurement theory.

Therefore, one ends with the "pessimistic" statement that, as yet, *the problem of "collapse" cannot be considered resolved within the quantum mechanics of open systems*, thus necessarily making the statements, such as, that the "collapse" makes these quantum eigenstates explicit, which bear apparent macroscopic meaning (e.g., the patterns of the neural networks), somewhat vague.

4. Discussion

The main point of this paper is the next statement: *if* (as it seems to be the case [13, 15, 16, 18]) the role of the "collapse" within the quantum modeling of consciousness should be considered substantial, then the quantum physics of consciousness meets serious obstacles - as outlined in Section 3.

However, the "pessimistic" conclusion of Section 3 should not be considered as "the end" of the "story". Furthermore, the experience with the modern quantum mechanics of open systems, likewise some recent breakthroughs [2, 7, 8, 15, 18], might open new avenues with this regard[7]. It seems very probable that, whatever the "possibilities" might be, they will exhibit the next general characteristics: (i) More-or-less significant change of the physical meaning of "collapse", and (ii) Abandoning of the (hypothesis of) universal validity of the Schrödinger law.

Needless to say, these expectations express some subjective point of view, but, nevertheless, there are some uncontroversial arguments in their support; here we shall briefly distinguish some of them, but the interested reader should refer to Appendix II, below.

[7] At the moment, there are three projects in this concern, coming from different areas of modern physics. The first project refers to the novel results [2, 8] of the encreasing field of quantum chaos. On the other side, the concept of the "objective reduction (collapse) - OR", as defined by Penrose [15], might have a *quantum-gravitational* origin in the, so-called, wormholes, as advocated by Rakovic [18]. Finally, the recent proposal of Dugic [7] calls for a *new paradigm* - nonunique physical time - and (in parallel to the ergodicity considerations [8]) being referred to the single (individual) physical systems (quantum "objects" and "apparatuses"), as opposed to the standard ensemble point of view.

The concept of "collapse" (as stated by von Neumann [23]), has already survived nontrivial change, basically for the original "definition" is not physically clear. For instance, nowadays one meets the concept of the "objective reduction (collapse) - OR", as introduced by Penrose [15]. As an intermediate step from von Neumann to Penrose, one can meet the different attempts, e.g., the theory of Rakovic [18], all of them participating in physical objectification of the "collapse". The "objectification" assumes the possibility of physical *observability* of the "collapse" (i.e., of the OR) - which puts specific emphases and limitations on the objectification of the "collapse", and of consciousness (un?)involved in it. Certainly, this is an open task whose perspectives, as yet, can hardly be predicted.

In conclusion, we shortly emphasize that the role of the "collapse" in physical modeling of consciousness bears ambiguities, which come from the unresolved problem of the "collapse" within the quantum measurement theory, and particularly within the quantum mechanics of open systems. Whether the interplay between the physics of consciousness and of the quantum measurement theory can provide some progress in this concern is, as yet, an open question to be answered, we believe, in relatively near future.

Appendix I

The objective of modern quantum measurement theory is the composite system "(quantum) object+apparatus+environment (o+A+E)". In this system, only the ("classical") apparatus (A) interacts with both, the (quantum) "object (o)", and with the (apparatus') environment (E). Note: interaction with environment is considered *unavoidable and continuous in time*, and is usually assumed to be strong; this is why the apparatus - within the quantum-mechanical treatment - is refered to as an *open* system. The interaction with the "object" is considered continuous, but only in a finite (macroscopically short) time interval.

As in the von Neumann's quantum measurement theory [23], one adopts the next *postulate/hypothesis*: for the "whole", o+A+E, one should consider the Schrödinger law (equation) valid, i.e. :

$$\Psi_{0+A+E} \equiv \hat{U}\Psi_0 \otimes \mathrm{X}_A \otimes \Phi_E = \sum_i C_i \Psi_{0i} \otimes \mathrm{X}_{Ai} \otimes \Phi_{Ei} \,, \qquad \text{(I.1)}$$

where the initial ("pure") quantum state of the object, $\Psi_O = \sum_i C_i \Psi_{Oi}$, $\hat{U}$ denotes the unitary time-evolution operator (the Schrödinger law), "$\otimes$" denotes the "tensor (direct) product" of states; the states Ψ_{Oi} constitute an orthonormalized basis in the Hilbert state space of the "object".

As it is usually outlined, *linearity* of $\hat{U}$ keeps the linear superposition involved in Ψ_O, and leads to the *correlations* of states of the subsystems, as explicit on the r.h.s. of (I.1).

On the other side, for the practical purposes, each subsystem, o, A, E (or o+A, A+E), can be formally represented by the "reduced density matrix", $\hat{\rho}_O, \hat{\rho}_A, \hat{\rho}_E$ (and so on), defined as:

$$\hat{\rho}_O = \sum_i |C_i|^2 \Psi_{Oi} \Psi_{Oi} * \qquad \text{(I.2a)}$$

$$\hat{\rho}_A = \sum_i |C_i|^2 \mathrm{X}_{Ai} \mathrm{X}_{Ai} * \qquad \text{(I.2b)}$$

and so on; the symbol "*" denotes the "hermitian conjugate".

Therefore, as regards the "object", quantum measurement formally reduces to the transition:

$$\Psi_0 \Psi_0^* \to \hat{\rho}_O \,, \qquad \text{(I.3)}$$

which is the *mathematical form of the "collapse"*. As regards the "whole", the same reads:

$$\Psi_{O+A+E} \Psi_{O+A+E}{}^* \to \hat{\rho}_{O+A+E} = \sum_i |C_i|^2 \Psi_{Oi} \Psi_{Oi}{}^* \otimes \mathrm{X}_{Ai} \mathrm{X}_{Ai}{}^* \otimes \Phi_{Ei} \Phi_{Ei}{}^* \,. \qquad \text{(I.4)}$$

[But *neither transition can be obtained via the Schrödinger law (equation)*. And this is the famous "quantum measurement problem".]

The very point of this appendix are the following non-equalities:

$$\Psi_{O+A+E}\Psi_{O+A+E}^{*} \neq \hat{\rho}_O \otimes \hat{\rho}_A \otimes \hat{\rho}_E, \qquad \text{(I.5a)}$$

$$\Psi_{O+A+E}\Psi_{O+A+E}^{*} \neq \hat{\rho}_{O+A+E}, \qquad \text{(I.5b)}$$

$$\hat{\rho}_{O+A+E} \neq \hat{\rho}_O \otimes \hat{\rho}_A \otimes \hat{\rho}_E. \qquad \text{(I.6)}$$

The *physical meaning* of (I.6) is probably obvious, and leads to the main point of Secion 3: After the collapse (cf. the r.h.s. of (I.4)), *no* subsystem (o, A, E) *can be considered to be in a definite quantum state* ($\hat{\rho}_O, \hat{\rho}_A, \hat{\rho}_E$). Otherwise, one would be able to put equality, "=", in Eq. (I.6): $\hat{\rho}_{O+A+E} = \hat{\rho}_O \otimes \hat{\rho}_A \otimes \hat{\rho}_E$; i.e., the assertion "the object is in a state $\hat{\rho}_O$, *and* the apparatus is in the state $\hat{\rho}_A$, *and* the environment is in the state $\hat{\rho}_E$", *is by definition* equivalent with the assertion "the composite system o+A+E is in the state $\hat{\rho}_O \otimes \hat{\rho}_A \otimes \hat{\rho}_E$ “.

This fact, well known in the foundations of quantum mechanics and quantum measurement theory (cf. also the recent preprint of d'Espagnat [4]), is a *feature of the "quantum nonseparability"* [3], and justifies to refer to $\hat{\rho}_O, \hat{\rho}_A, \hat{\rho}_E$ as to the *"improper mixtures"* [3]; formally exactly the same situation appears in the famous "EPR effect".

One may therefore conclude that the very openness of a quantum system (apparatus) does not by itself appear sufficient concerning both, establishing the "collapse" as an objective physical process (which would "offer" $\hat{\rho}_o, \hat{\rho}_A, \hat{\rho}_E$ as the objective quantum states), likewise the resolution of the quantum measurement problem. That is, *as regards the "collapse"*, the quantum mechanics of open systems suffers from exactly the same shortcomings as the original von Neumann's quantum measurement theory [23].

Appendix II

The physical contents of the term "collapse" have changed, especially in recent progress of this topic. And the main object of change is the *role of consciousness*.

In the original von Neumann's theory [23] the "collapse" is ultimatively refered to consciousness. More precisely: to *self-consciousness* of the observer, who is the final element of the von Neumann's [23] "chain" : "(quantum) object + apparatus + observer (o+A+O)". And the prefix "self" is substantial in this respect: the ability of the observer to be aware of his own (quantum) state is the unique cause of the "collapse". However, the *necessity* of *self*-consciousness is usually seen as *nonphysical* solution of the problem.

Recent progress in physical modeling of consciousness distinguishes the physically different point of view. E.g., in the physical model of consciousness of Rakovic [18], one meets consciousness interpreted as a physical "condition" sufficient for "channeling the collapse". As yet, it is not completely understood if consciousness (note: we do not mean *self*-consciousness) appears *necessary*[8] in this respect. We interpret this model as an intermediate step in obtaining a fully

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[8] This might be deeply connected with the role of "collective consciousness" (as a composite quantum state Φ of all "individual consciousness" ϕ_k : $\Phi \sim \prod_k \phi_k$) in quantum theory of measurement [2, 18, 23], where "collective consciousness" with its assembling (equivalent to convergence of Feynman's propagator quantum mechanics to one of its propagators, corresponding to Φ_i) contributes in channeling reduction of initial wave function Ψ into one of (possible) probabilistic eigenstates Ψ_i - which implies that "collapse" could be related with generation of microparticles' local wormholes in highly noninertial microparticle's interactions in quantum measurement situations [18] (fully equivalent to extremely strong gravitational fields according to the Einsten's Principle of Equivalence, when relativistic generation of wormholes is predicted [22]): so, in Penrose's gravitationally induced collapse [15] the very mechanism for this process could be continuous opening and closing of local microparticle's wormholes, addresses of

physical solution of the problem of "collapse" (i.e., in obtaining full objectification of the "collapse"). To this end, one should note that, once the physical consequences of the model [18] would be fully understood, it might prove that (in a long run) the model appears, by itself, to provide us with the basis of a full physical solution.

As a new prospect in objectification of the "collapse" appears the program formulated by Penrose [15]. Therein one meets the "objective reduction (collapse) - OR", as a *real, objective physical effect, which does not call for consciousness, at all*! However, this is, at the moment, just a program, within which the "objective collapse" appears merely as a convenient phrase.

References:

[1] Caldeira, A.O. and A.J. Leggett, 1983, Quantum Tunneling in a Dissipative System, Ann. Phys. (N.Y.) **149**, 374

[2] Cvitanovic, P., I. Percival and A. Wirzba (editors), 1991, Quantum Chaos - Quantum Measurement, Academic Publishers, Dodrecht

[3] D'Espagnat, B., 1971, Conceptual Foundations of Quantum Mechanics, MA: Benjamin, Reading

[4] D'Espagnat, 1998, Reply to Aharonov and Anandan's "Meaning of the Density Matrix", Los Alamos E-print archive, quant-ph 9804063 (unpublished)

[5] Dugic, M., 1996, On the Occurrence of Decoherence in Nonrelativistic Quantum Mechanics, Physica Scripta **53**, 9

[6] Dugic M., 1997, On Diagonalization of a Composite-system Observable. Separability, Physica Scripta **56**, 560; M. Dugic, 1998, Investigation of Separability of the Interaction Hamiltonian of a Composite System, J. Res. Phys., **27**, 141.

[7] Dugic, M., 1998, Many-Time Interpretation of the Quantum Measurement Process, Los Alamos E-print archive, quant-ph 9810029 (unpublished)

[8] Grigolini, P., 1993, Quantum Mechanical Irreversibility and Measurement, World Scientific, Singapore

[9] Jahn, R.G., 1982, The Persistent Paradox of Psychic Phenomena: An Engeneering Perspective, Proc. IEEE **70**, p. 136; and references therein

[10] Jibu, M. and K. Yasue, 1997, What is Mind? - Quantum Field Theory of Evanescent Photons in Brain as Quantum Theory of Consciousness, Informatica, **21**, 471

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their exits being related (probabilistically) to one of (possible) eigenstates Ψ_i of corresponding quantum system - and everything being related to corresponding (probabilistic) assembling Φ_i of "collective consciousness" [18]. The question how it is possible that these highly noninertial microparticles' processes with inevitable relativistic generation of the wormholes were not taken into account within quantum mechanics, which is yet extremely accurate theory, might be answered as it was, but within the ad hoc von Neumann's "projection postulate" [23] to account for quantum-mechanical "wave packet collapse" in quantum measurement situations (implying also that this ad hoc procedure is based on quantum gravitational phenomena, being on deeper physical level than quantum mechanical ones)! On the other hand, the nonlocality of "collective consciousness" provides an additional evidence that Quantum Mechanics is a nonlocal theory - demonstrated by tests of Bell's inequalities and the Einstein-Podolsky-Rosen "effect".

It should be also pointed out that the above-mentioned "collective consciousness" assembling Φ_i $(i = 1,2,3...)$ in quantum theory of measurement should be interpreted as purely probabilistic (with relative frequency of their appearance given by quantum-mechanical probability $|a_i|^2$ of realization of corresponding microparticle's eigenstates Ψ_i, where $\Psi = \sum_i a_i \Psi_i$), not depending on the previous history of the repeatedly prepared quantum system. However, this might not be the case for "individual consciousness" assembling, being history-dependent deterministic one (resulting in deterministic convergence of the consciousness-related-acupuncture EM/ionic MW/ULF oscillatory holographic Hopfield-like associative neural network to the particular attractor in the potential hypersurface, or equivalently to deterministic convergence of Feynman's propagator quantum mechanics to the particular propagator corresponding to ϕ_k , fixedly determined by "individual consciousness"), implying that strong preferences in individual futures might exist, governed by individual mental loads; the same may apply to collective futures Φ_i, too, governed by interpersonal mental loads [9, 18, 21].

[11] Joos, E. and H.D. Zeh, 1985, The Emergence of Classical Behaviour through Interaction with the Environment, Z. Phys. **B59**, 223
[12] Leggett, A. J., The Superposition Principle in Macroscopic Systems, in Foundations of Quantum Mechanics in the Light of New Technology, eds. S. Nakajima et al (World Scientific, Singapore, 1996), p. 35
[13] Marcer, P.J. and V. Schempp, 1997, Model of the Neuron Working by Quantum Holography, Informatica, **21**, 517
[14] Omnés, R., 1994, The Interpretation of Quantum Mechanics, Princeton University Press, Princeton
[15] Penrose, R., 1994, Shadows of the Mind. A Search for the Missing Science of Consciousness, Oxford University Press, Oxford
[16] Perus, M., 1997, System-Processual Background of Consciousness, Informatica **21**, 491
[17] Rakovic, D., and Z. Jovanovic-Ignjatic, 1998, Microwave Resonance Therapy and Acupuncture: New Prospects for Traditional Medicine, 14th Ann. Int. Symp. Acup. and Elec. Therap., New York, October 22-25; Z. Jovanovic-Ignjatic and D. Rakovic, A Review of Current Research in Microwave Resonance Therapy: Novel Opportunities in Medical Treatment, Acup. and Electro-Therap. Res., The Int. J., in press (1999); Rakovic D., Z. Jovanovic-Ignjatic, D. Radenovic, M. Tomasevic, E. Jovanov, V. Radivojevic, Z. Martinovic, M. Car, and L. Skaric, 1999, An Overview of Microwave Resonance Therapy and EEG Correlates of Microwave Resonant Therapy and Other Consciousness Altering Techniques, 10th Int. Montreux Congress on Stress, Montreux, Switzerland, February 28 - March 6 (to be published in Electro- and Magnetobiology)
[18] Rakovic, D., Brainwaves, Neural Networks, and Ionic Structures: Biophysical Model for Altered States of Consciousness, in D. Rakovic and Dj. Koruga, eds., Consciousness, Scientific Challenge of the 21st Century (ECPD, Belgrade, 1995), p. 291; D. Rakovic, 1997, Hierarchical Neural Networks and Brainwaves: Towards a Theory of Consciousness, in Lj. Rakic, G. Kostopoulos, D. Rakovic and Dj. Koruga, eds., Brain and Consciousness: Proc. ECPD Workshop, ECPD, Belgrade, p. 189; D. Rakovic, 1997, Prospects for Conscious Brain-Like Computers: Biophysical Arguments, Informatica **21**, p. 507; D. Rakovic and M. Dugic, 1998, Consciousness Mediated Quantum Gravitational Collapse via Generated Wormholes: From Macroscopic Biophysical to Microscopic Quantum Arguments, in P.P. Wang, ed., Proc. Joint Conf. Information Sciences, Vol. 2: 3rd Int. Conf. Comput. Intell. and Neurosci., Durham, NC, p. 265; D. Rakovic, Transitional States of Consciousness as a Biophysical Basis of Transpersonal Transcendental Phenomena, Int. Conf. Consciousness in Science and Philosophy, Charleston, IL, USA, November 6-7 (to be published in Int. J. Appl. Science and Computations); and references therein
[19] Ricciardi, L.M. and H. Umezawa, 1967, Brain and Physics of Many-Body Problems, Kybernetica, 4, 44
[20] Sit'ko, S.P. and L.N. Mkrtchian, 1994, Introduction to Quantum Medicine, Pattern, Kiev
[21] Swami Rama, 1978, Living with the Himalayan Masters, Himalayan Int. Inst. of Yoga Sci. and Phil., Holesdale, PA; K.C. Markides, 1990, Fire in the Heart. Healers, Sages and Mystics, Paragon House, New York
[22] Thorne, K.S., 1994, Black Holes and Time Warps: Eistein's Outrageous Legacy, Picador, London, Ch. 14; and references therein
[23] Von Neumann, J., 1955, Mathematical Foundations of Quantum Mechanics, Princeton University Press, Princeton
[24] Zurek, W.H., 1982, Environment-Induced Superselection Rules, Phys. Rev. **D26**, 1862
[25] Zurek, W.H., 1993, Preferred States, Predictability, Classicality and the Environment-Induced Decoherence , Prog. Theor. Phys. **89**, 281
[26] Zurek, W.H. asd J.P. Paz, 1994, Decoherence, Chaos and the Second Law, Phys. Rev. Lett. **72**, 2508