Consciousness: Scientific Challenge of the 21st Century, D. Raković, Dj. Koruga, eds., ECPD, Belgrade (1995)

BRAINWAVES, NEURAL NETWORKS, AND IONIC STRUCTURES: BIOPHYSICAL MODEL FOR ALTERED STATES OF CONSCIOUSNESS

Dejan Raković

Belgrade University, Faculty of Electrical Engineering
P.O.Box 816, 11001 Belgrade, Yugoslavia

Abstract. It is shown that neural networks with embedded "brainwaves" can cross the gap between the fast parallel unconscious mode of neuroscience and the slow serial conscious mode of psychology. The electromagnetic (EM) component of ultralowfrequency (ULF) "brainwaves" appears to enable perfect fitting with narrowed down limits of conscious capacity in normal awake states and very extended limits in altered states of consciousness - due to the biophysical relativistic mechanism of dilated subjective time base. It also enables the mixing of the normally conscious and unconscious contents in altered states, due to the relativistic Doppler mapping of the EM component of the "objective" ULF brainwave power spectrum on the zero-degenerate-frequency "subjective" one. An additional low-dielectric ($\varepsilon_r \approx 1$) weakly ionized gaseous neural network is necessary in these processes. This structure can be related to a displaced (from the body) part of acupuncture ionic system which can conduct ULF brainwave currents ~ 10^{-7} A, inside the conductive channels of the initial ionic concentration ~ 10^{15} cm^{-3}, with a tendency of deterioration during a period of ~ 1 hour. The ionized gaseous neural network, with embedded ULF brainwave currents, enables that "objective" distances can be "subjectively" optically recognized as much closer in altered states - due to the relativistic mechanism of the length contractions. Even some peculiar anticipating abilities of psyche are predicted in nonstationary ($\varepsilon_r \neq$ const) altered states during the interchange of normal and altered states of consciousness, due to the relativistic mechanism of time dilation (time warps) in highly noninertial "subjective" reference frame. All that provides an extraordinary biophysical basis for traditional psychology, including short-range and long-range transpersonal interactions and experiences down to the ultimate state of thoughtless consciousness. Notions, such as "qi", "subtle body", and "mental body", are physically inevitably associated with ions, displaced (from the body) part of acupuncture ionic structure, and in it embedded an EM component of ULF brainwaves, respectively. It should be pointed out that the above successes of the model finally provide possibility to incorporate consciousness inside an extended scientific paradigm, implying that consciousness is subtle internal display in the form of electromagnetic component of ULF brainwave ionic currents. The extended paradigm might have great influence on the fundamentals of neuroscience, psychology, medicine, biology, physics and computer sciences, with significant philosophical and religious implications.

***Key words**: Brainwaves, neural networks, ionic structures, consciousness, biophysics, relativistic & quantum physics, theoretical model.*

1. INTRODUCTION

There is a curious traditional dichotomy between psychologists and neuroscientists. Psychologists work with the slow, serial, and limited capacity component of the nervous system, which is associated with consciousness and voluntary control,

while neuroscientists work with the fast, parallel "hardware" of the nervous system, enormous in size and complexity, and unconscious in its detailed functioning. But what is the meaning of this dichotomy? How does a serial, slow, and relatively awkward level of functioning emerge from a system that is enormous in size, relatively fast-acting, efficient, and parallel? That is the key question.

Such a question has been addressed recently by Baars [1]. He has developed a very detailed cognitive model of consciousness, proposing that the split between psychologists and neuroscientists in looking at the nervous system reflects the global-workspace architecture. Global-workspace represents a kind of working memory or central information exchange, whose contents can be "broadcast" to the nervous system of distributed modules as a whole, allowing many different specialized modules in the brain to interact, competing or cooperating for access.

There is strong evidence [2] that parts of the extended reticular-thalamic activating system (ERTAS) serve as major facilitators of conscious experience, whereas the cortex of the brain provides the content of conscious experience. In that process, novel or significant information is amplified in respect to other which remains unconscious.

There is, also, another neurophysiological evidence [3] concerning stimulus habituation experiments with monitoring event-related potentials (ERPs) in the brain, that global broadcasting is associated with consciousness. Prior to habituation it has been found that activity related to a repeated visual stimulus can be found throughout the brain; but once habituation takes place, it can only be found in the visual system. However, are ERPs only a reflection of collective neuronal activity, or may also be transmitters of information, embodiment of consciousness itself, or all that together?

Of particular note are, also, recent observations [4,5] of 35-75 Hz oscillations, that seemingly appear in association with regions of the brain involved with conscious attention. These seem to have non-local properties related to transmission of information throughout the brain, too.

Our theoretical model [6-8] implies that the electromagnetic (EM) component of ongoing activity (EEG) and evoked potentials (EPs) (henceforth brainwaves) can be even closely related to global broadcasting associated with consciousness. However, it is necessary that complete information (both conscious and unconscious) is permanently coded from brain's neural networks to brainwaves, presumably as brainwaves spatiotemporal patterns of the brain ionic structure [3], resulting from the integral temporal changes and activations of the synaptic interconnections in the neural networks of the brain. It is also understood that the informational content of the individual "ego" is simultaneously excited (from the brain's neural networks to the brainwaves) whenever new information is excited.

The model perfectly fits with the narrowed down limits of conscious capacity in normal awake state (when brainwaves are predominantly located in the brain tissue with relative dielectric permittivity [9] $\varepsilon_r \gg 1$), and very extended limits in altered states of consciousness (REM sleep phase etc. [10], characterized by low-dielectric $\varepsilon_r \approx 1$ states in the framework of the model) - due to the biophysical relativistic mechanism of dilation of the subjective time base. It should be pointed out that purely biochemical mechanisms of the ERTAS (serving as a major facilitator of conscious experience, whereas the cortex of the brain providing the content of conscious experience, in the framework of Baars cognitive model [1]) cannot be accelerated up to several orders of magnitude in altered states, as compared to the normal awake state; however, they presumably affect ε_r, thus providing the bridge between biochemical and biophysical mechanisms.

In this review, details of the model will be presented, including brain's neural networks-brainwave interaction and information coding, extraordinary dilations of the subjective time base and mixing of normally conscious and unconscious contents in altered states, biophysical nature of low-dielectric ($\varepsilon_r \approx 1$) structure necessary for supporting the brainwaves in these states, biophysical basis of the traditional esoteric knowledge provided by the model, relationship between the quantum theory of measurement and consciousness, and independent experimental tests of the model.

2. A POSSIBILITY FOR BRAIN'S NEURAL NETWORKS - BRAINWAVE INTERACTION AND INFORMATION CODING

Information (thoughts) is presumably coded as brainwaves spatiotemporal patterns of the brain ionic structure [3], resulting from the permanent temporal changes and activations of the synaptic interconnections in the neural networks of the brain. These nonstationary brainwave patterns could be excited through one or more ultralowfrequency (ULF) channels [11]: $f_{o\gamma}^{obj}(30-50Hz)$, $f_{o\beta}^{obj}(13-30Hz)$, $f_{o\alpha}^{obj}(8-13Hz)$, $f_{o\theta}^{obj}(3{,}5-8Hz)$, and $f_{o\delta}^{obj}(0{,}5-3{,}5Hz)$, the first three of them predominantly corresponding to normally conscious states [12], and the last two corresponding to normally unconscious states [13]. The nonstationary brainwave ionic patterns are accompanied by the corresponding spatiotemporal patterns of electromagnetic (EM) waves, which is well described by Maxwell's equations of electrodynamics [14].

Most of the information processed in the brain's neural networks is normally unconscious, as only novel or significant information is passing the ERTAS threshold of consciousness, being emotionally and verbally modulated by nondominant (normally right) and dominant (normally left) cerebral hemisphere, respectively [15]. Amplified information is coded on three successive levels (neural networks,

brainwaves ionic currents, and EM component of brainwaves) in spatiotemporal form in γ, β and α channels; non amplified information is coded in θ and δ channels.

The existence of unconscious contexts during conscious processing of some information can easily be understood in normal awake states as overlapping process (during ~0.1 s [16]) of amplified (by ERTAS) brainwaves with conscious content and non amplified brainwaves with, therefore, unconscious contents, Fig.1(a). On the same line, contexts can become conscious in altered states of consciousness with ERTAS switched off (REM sleep phase [17], hypnosis [18], meditation [19], the psychedelic drug influence [20], some psychopathological states [21], and near-death experiences [22]), with extremely dilated subjective time base (Δt^{subj} » 0.1 s), when contexts contents are not more overlapped by previously existing normally conscious content, Fig.1(b).

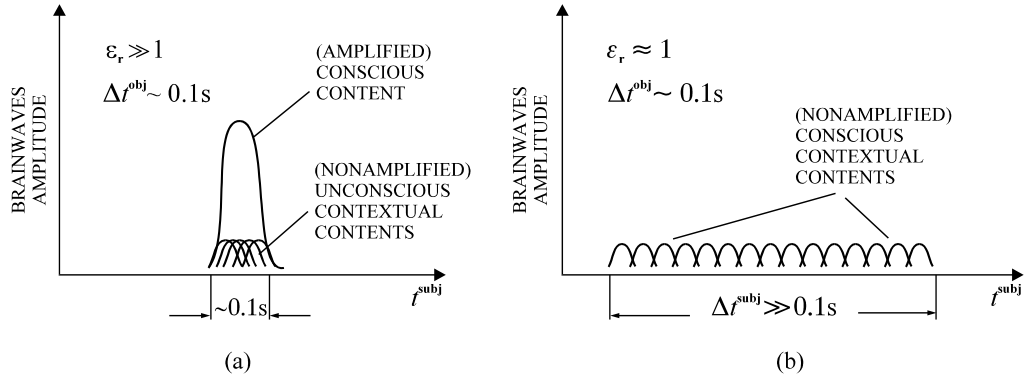

Figure 1 Schematic display of (a) overlapping process (during Δt^{subj} ~ 0.1 s) of amplified (by ERTAS) EM component of brainwaves with conscious content and non amplified EM component of brainwaves with unconscious contextual contents, in normal awake state (ε_r » 1), and (b) differentiated contextual contents, in altered states of consciousness ($\varepsilon_r \approx 1$), with extremely dilated "subjective" time base (Δt^{subj} » 0.1 s) - due to the biophysical relativistic mechanism of the model.

Alternatively, unconscious contents can be reached by consciousness when brain is tuned to ULF θ and δ channels, like in non-REM sleep phase, when these channels are significantly amplified, and the brainwaves spectrum is dominated by the slower waves of higher amplitude [12]. Naturally, one is aware of the unconscious information only in the non-REM sleep phase, forgetting it when the brainwaves shift to higher frequencies of the alert state - an exception being the information amplified to normally conscious level during the ERTAS awakening.

3. RELATIVISTIC MODEL FOR DILATION OF THE SUBJECTIVE TIME BASE

The only physical mechanism that can account for the extremely dilated subjective time base in altered states is the relativistic one [6-8], if only "subjective" observer can be associated with an EM component of brainwaves (and evoked potentials), which can move through the brain with relativistic velocities.[a)] In fact, the "subjective" reference frame is attached to the EM component of those brainwaves whose informational content refers to individual "ego" (or "self"); it is also understood that the informational content of the individual "ego" is simultaneously excited (from the brain s neural networks to the brainwaves) every time when new information is excited.

To be more specific, the ionic medium supporting propagation of the brainwave ULF ionic currents must be unhomogeneous, to ensure that the "subjective" observer (associated with the EM component of reference ULF brainwaves), moving through the part of medium of greater ε_r, could register time dilated information from faster EM component of brainwaves moving through the neighbouring part of medium of lower ε'_r (Fig.2; for further explanation cf. Eq.(1) and footnotes b and e). Then, at every moment the "subjective" observer is associated with the EM component of brainwaves in the dielectrically "denser" medium, and the whole such system behaves like some "center of consciousness". The informational content of such "subjective" observer is continuously replaced by a new incoming EM component of brainwaves. So, we have permanently some "stream of consciousness" [24]. More precisely, for inflowing information (in the form of ULF brainwaves ionic currents, coded in spatiotemporal patterns from the brain neural networks) to be recognized by the structured ionic medium, that medium itself must have a form of some kind of "optical" neural network - thus "subjective" observer being associated with the EM component of brainwaves in dielectrical "condensations" (of greater ε_r), behaving like "distributed centers of consciousness"!

By attaching the "objective" reference frame to the brain (i.e. laboratory) which moves relatively to the "subjective" reference frame with velocity [25] $v = c_o / \sqrt{\varepsilon_r}$ (where c_o denotes the propagation velocity of the EM field in vacuum, and ε_r the ULF relative dielectric permittivity of the denser ionic structure where

---

a) In order to be able to attach the inertial observer to the EM component of brainwaves, it is necessary to show that the velocity of other EM waves is invariant (and equal c) in respect to the reference EM wave; this can be readily shown by applying the relativistic formula for the composition of velocities [23]: $(c - v)/(1 - vc/c^2) = c$, for $v = c_o / \sqrt{\varepsilon_r} \leq c = c_o / \sqrt{\varepsilon'_r}$ (cf. Fig.2 for notations). Such an "subjective" observer (S_{subj}) would register all relativistic effects as any other object (equiped with instruments) moving inertially with velocity $v = c_o / \sqrt{\varepsilon_r}$ in respect to the brain (and the related "objective" laboratory reference frame S'_{obj})!

brainwaves propagate), the relativistic relation between the time intervals [23], from the viewpoint of the inertial "subjective" observer ($v = c_o / \sqrt{\varepsilon_r} = \text{const}$), is [b)]

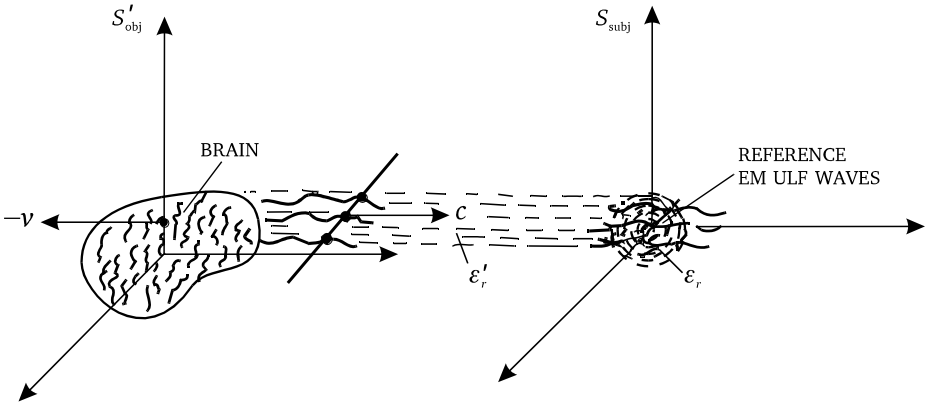

Figure 2 Figure accompanying the explanation for the necessity of the structured dielectric ($\varepsilon_r > \varepsilon'_r$) ionic medium, to ensure that the "subjective" observer (S_{subj}), related to EM field moving through the part of medium of greater ε_r, could register time-delated information from faster EM waves moving through the neighboring part of medium of lower ε'_r. More precisely, for inflowing information (in the form of EM field of ULF brainwave ionic currents, coded in spatiotemporal patterns from the brain neural networks) to be recognized by the structured ionic medium, that medium itself must have a form of some kind of "optical" neural network - thus "subjective" observer S_{subj} being associated with the EM component of brainwaves in dielectrical "condensations" (of greater ε_r), behaving like "distributed centers of consciousness"!

$$\Delta t^{subj} = \frac{\Delta t_o^{obj}}{\sqrt{1-\frac{v^2}{c^2}}} = \left. \frac{\Delta t_o^{obj}}{\sqrt{1-\frac{\varepsilon'_r}{\varepsilon_r}}} \right|_{\frac{\varepsilon_r}{\varepsilon'_r} \approx 1} >> \Delta t_o^{obj} , \qquad (1)$$

where $c = c_o / \sqrt{\varepsilon'_r}$ denotes the propagation velocity of the incoming EM field inside the neighbouring part of ionic structure with lower dielectric permittivity ($\varepsilon'_r < \varepsilon_r$, cf. Fig.2). This could account for the striking dilatations of the subjective time base

---

b) In Eq.(1) the velocity c necessarily corresponds to propagation velocity of EM field in dielectric medium (not in vacuum), as only in this case Maxwells equations in (homogeneous) dielectric medium (characterized by ε'_r) are Lorentz-invariant. In nonhomogeneous medium ($\varepsilon'_r < \varepsilon_r$), Eq.(1) can only be considered as approximation (of the general relativistic one), which can be considered satisfactory for linear dimensions of locally denser medium (of greater ε_r) significantly shorter in respect to linear dimensions of the neighbouring medium (of smaller ε'_r). Also, Eq.(1) does not apply to dielectrically homogeneous medium, where $\varepsilon'_r = \varepsilon_r$ (cf. footnote e). The same refers to Eqs.(2)-(3).

(Δt^{subj}) in comparison with the objective time that measures the laboratory clock (Δt_o^{obj}), in altered states of consciousness.

The condition $\varepsilon_r/\varepsilon_r' \approx 1$ can be achieved only in a low-dielectric weakly ionized gaseous structured medium (with $\varepsilon_r \geq \varepsilon_r' \approx 1$), as the brain is a highly nonhomogeneous structure where ε_r could range from $\varepsilon_r > 2$ (characteristic of biopolymers) across $\varepsilon_r \approx 81$ (characteristic of free tissue water) to $\varepsilon_r \sim 10^5$ (characteristic of cell membranes, with striking polarization of the volume ion density within the porous cell wall, strongly depending on metabolic cell processes) [9]. Biophysical nature of the low-dielectric weakly ionized gaseous structured medium (with $\varepsilon_r \geq \varepsilon_r' \approx 1$) will be considered extensively later on.

The relativistic relation between the frequencies [26] measured in the two reference frames, moving away from one another ($\alpha = \pi$), is

$$f^{subj} = f_o^{obj} \left. \frac{\sqrt{1-\frac{v^2}{c^2}}}{1-\frac{v}{c}\cos\alpha} \right|_{\alpha=\pi} = f_o^{obj} \left. \frac{\sqrt{1-\frac{\varepsilon_r'}{\varepsilon_r}}}{1+\sqrt{\frac{\varepsilon_r'}{\varepsilon_r}}} \right|_{\frac{\varepsilon_r}{\varepsilon_r'}\approx 1} << f_o^{obj}, \qquad (2)$$

which describes the striking relativistic Doppler shift of the excited "objective" brainwave frequency (f_o^{obj}) down to the vanishing "subjectively" observed brainwave frequency ($f^{subj} \approx 0$ Hz) [c] in low-dielectric ($\varepsilon_r \geq \varepsilon_r' \approx 1$) altered states. This can account for the mixing of conscious and unconscious contents in the altered states of consciousness, as five main frequency bands of both the spontaneous (EEG) and evoked (EP) brainwave activities, $f_{o\gamma}^{obj}(30-50\text{Hz})$, $f_{o\beta}^{obj}(13-30\text{Hz})$, $f_{o\alpha}^{obj}(8-13\text{Hz})$, $f_{o\theta}^{obj}(3{,}5-8\text{Hz})$, and $f_{o\delta}^{obj}(0{,}5-3{,}5\text{Hz})$, the first three of them predominantly corresponding to normally conscious states [12] and the last two corresponding to normally unconscious states [13], for $\varepsilon_r/\varepsilon_r' \approx 1$ start merging from the viewpoint of the "subjective" reference frame: $f_\gamma^{subj} \approx f_\beta^{subj} \approx f_\alpha^{subj} \approx f_\theta^{subj} \approx f_\delta^{subj} \approx 0$ Hz, Fig.3. Although the "objective" brainwave power spectra in such states do not differ significantly from the spectrum of the alert state [27], the essential difference appears in the "subjective" brainwave power spectra; for the sake of comparison, in the alert state the brainwaves are predominantly located in the brain tissue (with $\varepsilon_r \gg 1$), when a differ-

[c] This does not diminish the rate of "subjective" information processing, as this process is not serial but parallel (both in spatiotemporal and frequency domains), being enhanced on "subjective" level by greatly enlarged temporal resolution due to extremely dilated "subjective" time base in altered states of consciousness (cf. Fig.1(b)).

entiated "subjective" spectrum exists: $f_i^{subj} = f_{oi}^{obj}\sqrt{1-\varepsilon'_r/\varepsilon_r}\Big/\left(1+\sqrt{\varepsilon'_r/\varepsilon_r}\right)$, i = γ,β,α,θ,δ, cf. Fig.3.

This could be biophysical mechanism of *dreams*, which particularly implies their psychological significance: in dreams one has continuous access and more efficient "subjective" integration of normally conscious and unconscious contents, giving rise to integration and growth of human personality (otherwise divided into conscious and unconscious associative "ego" states), which results in alleviation of emotional conflicts!

So, one can state that there are two levels of information coding in brain-like conscious neural networks: spatio-temporal level of information coding (as the only one in contemporary artificial neural networks [20]) and ultralowfrequency level (which also exists in biological neural networks, and is responsible for conscious and unconscious states, according to the model).

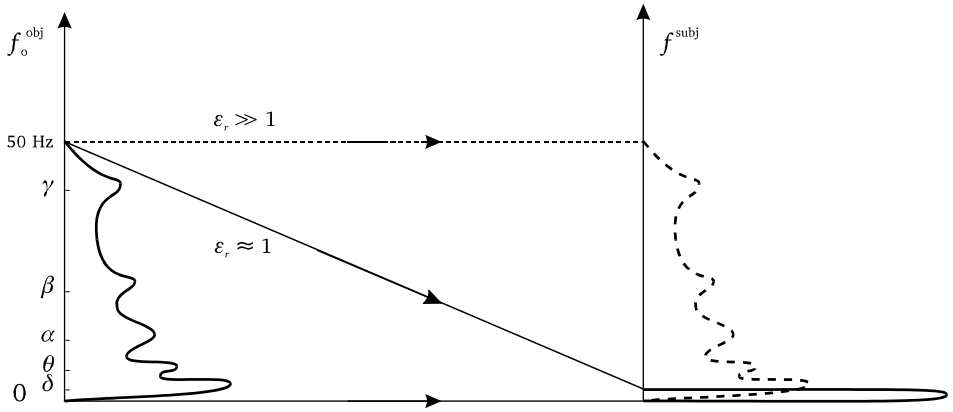

Figure 3 Display of Doppler mapping of electromagnetic component of the "objective" brainwave power spectrum on the "subjective" one, in psychologically altered states ($\varepsilon_r \approx 1$, solid line), and normal awake states ($\varepsilon_r \gg 1$, dashed line).

4. BIOPHYSICAL NATURE OF A LOW-DIELECTRIC ($\varepsilon_r \geq \varepsilon'_r \approx 1$) STRUCTURE

Now we shall consider biophysical nature of a low-dielectric ($\varepsilon_r \geq \varepsilon'_r \approx 1$) medium that supports the propagation of brainwaves in altered psychological states.

(a) That medium must be unhomogeneous, to ensure that the "subjective" observer (associated with the EM component of reference ULF brainwaves), moving through the part of medium of greater ε_r, could register time dilated information

from faster EM component of brainwaves moving through the neighboring part of medium of lower ε_r' (Fig.2). Then, in every moment the "subjective" observer is associated with the EM component of brainwaves in the dielectrical condensations of the low-dielectric structured medium, with "distributed centers of consciousness". The informational content of such "subjective" observer is continuously replaced by a new incoming EM component of brainwaves. So, we have permanently some "stream of consciousness" [24].

(b) The low-dielectric medium must be gaseous [29] and weakly [30] ionized ($\varepsilon_r \approx 1$) to conduct ULF ionic currents, accompanied by an EM field - associated with the "subjective" observer. Also, it must be displaceable from the brain neural networks, but in mutual electrical connection to achieve the continuous inflow of information from the networks.

(c) For inflowing information (in the form of ULF brainwave currents, coded in spatiotemporal patterns from the brain neural networks) to be recognized by the weakly ionized gaseous structured medium - that medium must have a form of some kind of gaseous ionic "optical" neural network.

(d) For the EM component of brainwaves (and associated "subjective" observer) to be localized (not irradiated), brainwaves i.e. ionic currents must be ultralowfrequency ones - as intensity of the irradiated field is then extremely low (intensity I of the field of frequency f, irradiated from a dipole source of linear dimensions d, has a dependence $I \sim f^4 d^2$ [14]).

(e) The ionic concentration n_j in the channels of the weakly ionized gaseous neural network can be estimated by taking the average ionic drift velocity to be of the same order of magnitude as its thermal velocity [31], $\bar{v}_d = \left(3kT/m_j\right)^{1/2} \sim 10^3$ m/s ($m_j \sim 10^{-26}$ kg is an ionic mass, and $k = 1.38 \cdot 10^{-23}$ J/K is the Boltzmann constant); then from the expression for the ionic current one obtains $n_j = I_o / e\bar{v}_d r^2 \pi \sim 10^{15}$ cm^{-3}, for the cellular dimension channel radius ($r_j \sim 1$ μm) and brainwave ionic currents ($I_o \sim 10^{-7}$ A [32]). This ionic concentration is significantly lower than the molecular concentration in the air ($\sim 10^{19}$ cm^{-3}), which a *posteriori* implies that this gaseous structure is weakly ionized.

(f) One can conjecture that the biophysical basis of the low-dielectric weakly ionized gaseous "optical" neural network is the part of the acupuncture system displaced from the body, of an estimated ionic concentration $\sim 10^{15}$ cm^{-3}, carrying ULF currents $\sim 10^{-7}$ A. It should be pointed out that the displaced part has a significant tendency to deterioration, as the partial ionic pressure at room temperature ($T \sim 300$K), $n_j kT \sim 1$ Pa, is much greater than the magnetic pressure which confines the channel [33], $\mu_o I_o^2 / 8\pi^2 r^2 \sim 10^{-10}$ Pa ($\mu_o = 12.566 \cdot 10^{-7}$ H/m is the magnetic permittivi-

ty of vacuum).[d] Characteristic diffusion time τ for the ionic channel deterioration can be estimated as $\tau = L^2/D \sim 1$ h, where $D \sim 0.2$ cm^2/s is the diffusion coefficient under normal conditions in air [34] and $L \sim r \sim 30$ cm is the diffusion length estimated from the expression for the ionic current (from $I_o \sim 10^{-7}$ A is $n_j r^2 \sim 10^7$ cm^{-1}, and at the end of the deterioration process the ionic concentration of the channel reaches that one in air $\sim 10^4$ cm^{-3} [35], from where $r \sim 30$ cm).

(g) The obtained diffusion time of ~ 1 h matches well with the 90-120 minute ultradian rhythms of both waking conscious experience and nonREM-REM sleep alterations [36], and can be the cause of corresponding changes in subjective experience from normal to altered states (with extremely dilated subjective time base, and mixing of normally conscious and unconscious contents). In fact, referring to Figs. 1 and 3, it can be said that in normal state brainwaves propagate only through the structured brain tissue with $\varepsilon_r \gg 1$ (Fig.1(a)). On the other hand, altered states with extremely dilated subjective time base, and mixing of normally conscious and unconscious contents, are always accompanied by generation of displaced part of ionic acupuncture system with $\varepsilon_r \approx 1$ (Fig.1(b)), with ERTAS switched off. In the later case, brainwaves are propagating both through the brain tissue and displaced part of ionic acupuncture system, but conscious contribution of the first ones is negligible due to the overlapping of non amplified contents, while the second ones give rise to conscious contribution due to good temporal differentiation of the same contents. So, it seems that condition for existence of altered states of consciousness is both switched off ERTAS and generation of the displaced (from the body) part of acupuncture ionic system (the ERTAS switching off being presumably one of the trigger mechanisms for activation of some biochemical processes responsible for generation of displaced part of ionic structure). The first condition is, for instance, typically fulfilled in sleep, while the second one is then realized with a periodicity of ~ 90-120 min in REM-sleep phase, with abundance of dreams mixing the normally conscious and unconscious contents.

5. BIOPHYSICAL BASIS OF THE TRADITIONAL ESOTERIC KNOWLEDGE

---

[d] The stability condition would be fulfilled under equilibrium of the diffusion and magnetic pressures: $n_j kT = \mu_o I_o^2 / 8\pi^2 r^2$, where $I_o = e n_j \bar{v}_d r^2 \pi$. From these relations one obtains $n_j = 8kT / \mu_o e^2 \bar{v}_d^2 r^2 \sim 10^{24}$ cm^{-3}, for already used numerical data. It is obvious that this concentration exceeds by ~ 10^9 times that one in the displaced deteriorating ionic structure, and that greater would be the current I_o flowing through the ionic channels ($I_o \sim 100$ A), which is clearly incompatible with biological systems.

It should be pointed out, quite unexpectedly, that the model provides an excellent biophysical framework for traditional esoteric knowledge, which will be clear from further analysis.

As a consequence of the deterioration process, the displaced part of the ionic acupuncture system can be finally "emitted" together with the informational content of the embedded ULF EM waves. Even the conditions for ULF EM field localization are not fulfilled at the end of deterioration process, as then ULF brainwave currents can flow through the surrounding weakly ionized ($\sim 10^4$ cm^{-3}) atmosphere, which significantly enlarges linear dimensions of the dipole source and therefore the intensity of irradiated ULF EM field. This can provide the biophysical basis for some extrasensory perceptions [37]: it is only necessary for phases of 90-120 minute ultradian rhythms of two persons to be matched, and exchanged information to be emotionally colored by ERTAS of receiver - which can explain why this phenomenon is mainly recognized between twins, mother and child, or otherwise closely related persons. Even long-range phenomena of this type are energetically supported by existence of extremely low attenuation at ULF frequencies due to "Schumann resonances" of the earth-ionosphere cavity, well matched with EEG-spectrum [38]. The above mechanism has probably been of adaptational significance for animal species, in highly efficient global spreading of surviving-important novel information [39]. Inside the human population, it seems that the Maharishi effect is providing evidence [40] for the above possibility - which can be biophysical basis of Jung's collective unconscious [41]. In that context, it could be said that ionosphere represents a dynamic collective memory of all biological species, which is continuously being refreshed by biological units with periodicity and phase of their ultradian rhythms.

Further deterioration of the points of displaced part of the ionic acupuncture system makes the whole ionic system homogeneous, without a possibility for new information to reach the subjective reference ULF EM component of brainwaves [e)], bringing the ultimate transpersonal state of thoughtless consciousness (*nirvana*, *samadhi*, *satori*, *enlightenment*, ... [43]). Objectively, the whole ionic system is completely open for information exchange in ULF domain, bringing a sense of oneness with the surrounding world, and subjectively, this is the state of empty consciousness, although the brain neural network can be still very active. This state elapses very shortly in nontrained persons, but can be presumably prolonged in yoga-like trained persons. The lost part of the ions (of the initial concentration $\sim 10^{15}$ cm^{-3}) is insignificant in comparison with that which exists in the body ($\sim 10^{20}$ cm^{-3} [44]), and can even be regenerated during the breathing process in ~ 1 h.

[e)] In fact, the "proper time" ("subjective" time) for photons in dielectrically homogeneous medium is identically zero [42], this preventing any "stream of consciousness" (in contrast to situation for nonhomogeneous low-dielectric medium, when "subjective" time is highly dilated, cf. Fig.1(b)).

In the framework of the model, biophysical nature of the ultimate goal of yoga and related esoteric disciplines [43] is the prolongation of altered state to 24 hours a day, with displaced ionic system continuously opened. This means that ultradian rhythm does not exist any more, which can be achieved through the gradually enhanced functional connectioning of the left and right brain hemispheres (their prevailing dominance being normally governed by ultradian rhythm [45]). In prolonged altered state (yoga and related esoteric disciplines) one has continuous access and more efficient "subjective" integration of normally conscious and unconscious contents (cf. Fig.3), this being their major role in the growth of human personality. Finally, when displaced ionic system becomes continuously homogeneous it also becomes "objectively" opened to ULF interactions, achieving the continuous state of oneness with surrounding world (this being "subjectively" accompanied by the state of empty consciousness).

It should be noted that some peculiar relativistic effects are predicted by the model in spatial domain [23], in altered states of consciousness (when $\varepsilon_r/\varepsilon'_r \approx 1$):

$$\Delta l^{subj} = \Delta l_o^{obj}\sqrt{1-\frac{v^2}{c^2}} = \Delta l_o^{obj}\sqrt{1-\frac{\varepsilon'_r}{\varepsilon_r}}\Bigg|_{\frac{\varepsilon_r}{\varepsilon'_r}\approx 1} << \Delta l_o^{obj}, \qquad (3)$$

where Δl^{subj} is the length optically perceived by the "subjective" reference frame, and Δl_o^{obj} is the length measured in the "objective" reference frame. So, the weakly ionized gaseous neural network, with embedded ULF brainwave currents, enables that even long "objective" distances can be "subjectively" optically recognized as very close - due to the relativistic mechanism of the length contractions. Even more, such displaced ionic "optical" neural network can perceive an environment panoramically, which is reported by reanimated patients [22]. This can provide another type of extrasensory perception in optical domain, which is not limited by ultradian rhythms influencing the possibility for long-range interactions in ULF domain, as it was mentioned above (much higher frequencies in optical domain can be easily emitted and received, by the weakly ionized gaseous neural networks in altered states, at any time!).

Both of the transpersonal interactions mentioned above were of the long-range type. However, the model predicts also the short-range transpersonal interactions without any waves emitted, due to electromagnetic induction coupling between two neural networks with embedded ULF brainwaves. The situation is similar to that one in primary and secondary coils in electrical transformers, with the only difference that not only energy but also information is transferred from one neural network to another. This could be the biophysical basis for nonverbal hypnosis, suggestion, etc. which are also not limited by ultradian rhythms, as there is no wave emission in the ULF domain. They are even possible in both normal and altered states of consciousness.

Even some peculiar anticipating abilities of psyche [37] can be presumably accounted by nonstationary states between the interchange of normal and altered states of consciousness (when brainwaves traverse from high-dielectric (ε_r » 1) to low-dielectric ($\varepsilon_r \approx 1$) state or *vice versa*, the relative velocity $v = c_o/\sqrt{\varepsilon_r}$ of "subjective" reference frame being subjected to abrupt change in short transitional period t ~ 0.1 s, with "subjective frame" acceleration ~ $c_o/\tau \sim 10^9$ m/s^2). Let us consider the nonstationary process as a superposition of two short stationary processes (both elapsing ~ 0.1 s, before and after interchange of states of consciousness), and one short nonstationary process of interchange of states of consciousness (elapsing ~ 0.1 s), cf. Fig.4(a). From the point of view of "subjective" reference frame, in normal high-dielectric stationary state ($\varepsilon_r \gg \varepsilon'_r \gg 1$) is $\Delta t^{subj} = \Delta t^{obj}/\sqrt{1-\varepsilon'_r/\varepsilon_r} \sim 0.1\,s$, and in altered low-dielectric stationary state ($\varepsilon_r \geq \varepsilon'_r \approx 1$) is $\Delta t^{subj} = \Delta t^{obj}/\sqrt{1-\varepsilon'_r/\varepsilon_r} \gg 0.1\,s$. In transition from the normal high-dielectric ($\varepsilon'_r \gg 1$) to altered low-dielectric ($\varepsilon_r \approx 1$) state (with striking "subjective frame" acceleration) is [46] $\Delta t^{subj} = \Delta t^{obj}\sqrt{1-\varepsilon'_r/\varepsilon_r}$, which has no real solution; but, any successive interaction of the low-dielectric ($\varepsilon'_r \approx 1$) displaced part of ionic acupuncture system with the high-dielectric (ε_r » 1) body [f] or any other surrounding non-low-dielectric ($\varepsilon_r > 2$) object - will give rise to real solution $\Delta t^{subj} = \Delta t^{obj}\sqrt{1-\varepsilon'_r/\varepsilon_r} \sim 0.1\,s$, with summarized $\Delta t^{subj} >> \Delta t^{obj}$ for two short stationary processes and one short transitional nonstationary process (cf. Fig.4(a)). However, as the whole process is nonstationary and the "subjective" reference frame is noninertial, according to the theory of relativity [46] there *must* be $\Delta t^{subj} << \Delta t^{obj}$! [g] This can be achieved if only the "objective" time interval refers to one of the future "objective" reference frames ($\Delta t^{subj} << \Delta t^{obj}_{fut}$, cf. Fig.4(c)), i.e. if only "subjective" reference frame correlates with one of the future "objective" reference frames (not with the present "objective" reference frame!) in nonstationary altered states! Such "subjectively" recognized future information can be then transferred to the brain neural network, through continuously existing electrical connection between the body and displaced part of ionic acupuncture system. The above analysis also implies that relativistic biophysical communication between "subjective" and present "objective" reference frames is forbidden during the interchange of states of consciousness!

---

[f] Actually, the electrostatic skin barrier imposes an restitutional attracting force for displacing part of ionic acupuncture system, this giving rise to successive interaction of the low-dielectric displaced part of ionic acupuncture system with the high-dielectric body.

[g] Let us remind ourselves of Einstein's "twin paradox", where - after cosmic trip with relativistic velocities - the slightly aged twin-astronaut reaches his grown aged twin-brother in the Earth. This is a cosequence of the accelerated relativistic movement of twin-astronaut in non-inertial reference frame, in respect to his twin-brother, who spent his life in the Earth inertial frame. In such a case, the time unequivocally elapses much more slovely in relativistic non-inertially moving reference frame, i.e. applied to the nonstationary altered states, $\Delta t^{subj} \ll \Delta t^{obj}$!

Deeper understanding of physical mechanisms of (acausal) precognitive processes obviously sinks into the General theory of relativity, applied to highly noninertial reference frames (like in enormously strong gravitational fields, where similar phenomena are expected [47]). From the point of view of the General theory of relativity, physical processes in accelerated reference frame outside gravitational field and in that one inside gravitational field with equivalent (gravitational) acceleration - are identical (the so called Principle of equivalence, being one of the fundamentals of Einstein's theory of gravitation). Theoretical analyses show that in enormously strong gravitational fields the so called wormholes (or Einstein-Rosen space-time bridges) are created, whose entrance and exit could be in very distant space-time points. As in transitional states of consciousness the "subjective" reference frame, related to EM field of brainwaves, is subjected to quick change of velocity, with equivalent acceleration comparable with that one in enormously strong gravitational field of wormholes, according to the Principle of equivalence one could expect, in such brief states, the creation of Einstein-Rosen bridge and tunneling of "subjective observer", i.e. consciousness, in previously "mentally addressed" exit in space-time [h] - reminiscences on passing through some tunnel being really reported by many patients reanimated from clinical death [22]! It should be pointed out that apart from the EM field, the displaced part of ionic acupuncture system (in the form of ionic neural network, having the "optical" sensory function) must also be tunneled in such (acausal) interactions of consciousness with distant events in space-time!

This could be a biophysical mechanism of the so called "astral projections" of consciousness [i], those presumably being the basis of most psychic phenomena categorized in

---

h) To support this, one can cite the technique adopted by "extrasenses" when they want to achieve some distant influence: they always intensely visualize the person or place, as mental targets! On the other hand, this could be deeply connected with the role of consciousness in quantum theory of measurement, where consciousness with its act of observation affects the final collapse of the initial wave function into one of possible probabilistic eigenstates - which implies that the collapse could be related with generation of local Einstein-Rosen bridge (see the next section, for more details).

i) Some theoreticians of gravitation have pointed out potential possibility of practically instantaneous trips in space-time by using wormholes, provided they are stabilized by so called "exotic matter", which pushes the wormhole's walls apart, (anti)gravitationally - as a consequence of the wormhole's negative average energy density, as seen by a light beam traveling through it (such anomalous kind of matter does really exist in strong gravitational fields, as the vacuum fluctuations near a black-hole's horizon are essentially exotic) [47]! The same mechanism, which can achieve space-time tunneling of displaced gaseous ionic neural network in transitional states of consciousness (invoking biologically induced gravitational anomalies in transitional states of consciousness, in general) by virtue of relatively weak ULF EM fields of brainwaves, $\sim 10^{-1}$ V/cm [9], reveals also possibility for tunneling more massive objects by using stronger ULF EM fields. However, a careful control of transitional states of consciousness, mental addressing, and necessary intensity of ULF EM field to amplify the effect - is needed. Presumably years of hard theoretical and experimental investigations will be necessary, but it seems that there are no fundamental obstacles in exploiting that mechanism for future fast space-time trips.

[37] (providing also explanation for transitional nature and difficult reproducibility of these phenomena)! In particular, reincarnation could be possibly traced as a result of the post-mortal mentally loaded (karmical) addressing of the deceased ionic structure: as a consequence, reincarnational cycles are to be expected between karmically related persons [j)] - which is widely claimed in Eastern esoteric tradition [48]! In that process, the non-low-dielectric barriers in interaction with the non-low-dielectric deceased ionic structure are also inducing transitional states of consciousness, revealing that high-dielectric barriers are helping in overcoming themselves in these "astral projections" - quite opposite to normal experience in usual mechanical interactions [43]!

The predicted nonstationary altered states could also be the biophysical basis of anticipation [k)] in intuition, precognition and deep creative insights [l)] - which could be easily put under control by "mental addressing" on chosen problem, shortly before a waking-sleep transitional state! On awaking, the brain would then amplify the dream concerning the solution of addressed problem, giving to it the priority in respect to other processed information during the sleep phase. The information obtained in this way is usually mixed through associative coupling with other conscious and unconscious pieces of information during the following REM-sleep periods - having therefore some symbolic form, which has to be decoded through introspective analysis of the dream. Naturally, to solve some scientific, technical or artistic problem in this way, it is necessary for the person to be expert in the field, in order to articulate the obtained solution in corresponding scientific, technical or artistic "language".

[j)] Therefore, moral might be of ultimate practical significance for both individuals and civilization, especially taking into account that contents of our thoughts are presumably periodically emitted in ionosphere (with ultradian rhythmicity ~1.5-2 h, as mentioned above), further on influencing backward the human population globally. Such global information processing on the ionospheric level is enabled by inhomogeneities in its ionic structure due to local variations of the Earth magnetic field, implying that ionosphere behaves as a giant "optical" neural network, with ionic channels of greater conductivity in respect to local environment.

[k)] According to the computer experiments with random number generators [49], only nonactualized possible futures can be anticipated (more accurately for *a priori* greater probabilities of their realization), in accordance with quantummechanical wievpoint, described in the next section.

[l)] Even deep artistic experiences of spectators might have strong spiritual note - through spontaneous spectator's "addressing" on the masterpiece (exciting him in altered state of consciousness), and through it on the illuminating idea related to the artist in the moment of masterpiece creation. The same might apply to performers in performing arts. The whole situation arises associations on contacts with Plato's world of ideas - this being the world of virtual possibilities, according to our model (cf. foot note k). What is the physical nature of this world is still an open question, but one possibility is that it can be a world of ionic archetypic structures (astral world!? [43]) preshaping possible futures, described by wave functions Φ_i of "cosmic consciousness" (see the next section for further elaboration).

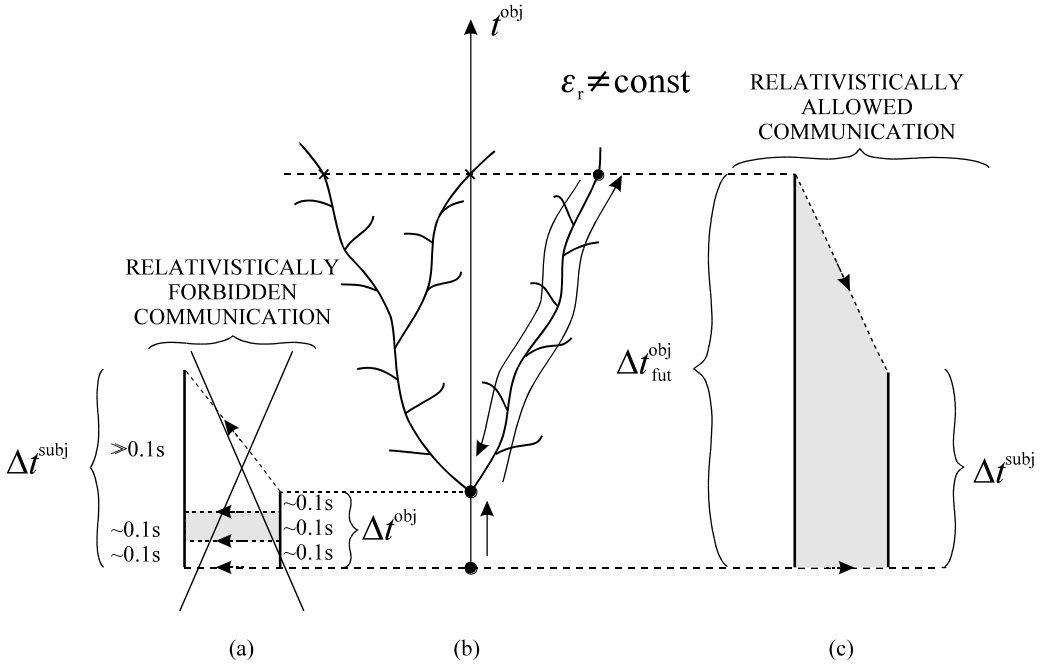

Figure 4. The schematic "subjective" view of relations between the "subjective" time interval (Δt^{subj}) and (a) the present "objective" time interval (Δt^{obj}), and (c) the future "objective" time interval (Δt^{obj}_{fut}), respectively, in nonstationary transitions from normal to altered states or vice versa (when $\varepsilon_r \neq$ const.). In Figure 4(b) the possible future alternatives are depicted; for relation to interpretation of quantum mechanics, see the next section.

It should be also pointed out that the ionic nature of the acupuncture system supports the possibility that ions in air (*prana, qi, pneuma, etheric vitality!?*) can be physiologically effective [35], just through the acupuncture ionic system and biophysical mechanisms that lie in the basis of acupuncture regulation [50] (out of them, the positive ions have an exciting influence (*yang!?*) and the negative ones an inhibiting influence (*yin!?*) [35]). So, qi (sometimes erroneously referred as a new kind of biological energy, *bioenergy*) can be related to ions flowing through the ionic channels of the acupuncture system in the form of ULF ionic currents, with informational content coded in spatio-frequency form of currents and EM fields. In support to the ULF nature of ionic currents in acupuncture channels, one can cite the resonance ULF (~ 4 Hz) stimulation of the acupuncture analgesia endorfin mechanism [51]. It should be pointed out that a lot of experimental phenomena related to external *qi gong* treatment [52] can be reconciled with (ULF) ionic nature of qi. So, it seems that the healing process can be related with the transfer of ions between the healer and healee, and/or transfer of the EM information patterns responsible for normal functioning of acupuncture system and overall health. Also, the "astral pro-

jections" of displaced ionic structure in remote diagnosis and spiritual healing (including prayer addressed on ionically abundant disembodied archetype structures; cf. footnote d) [53,54] could be expected.

Also, it seems that esoteric notions such as *subtle body* (*manomaya, lingasarira, manovijnana, ka, psyche, astral body, psychic body, ...*) and *mental body* (*vijnanamaya, suksmasarira, manas, ba, thymos, mind, noetic body, ...*) [43] are biophysically inevitably associated with a partly displaced (from the body) ionic acupuncture system, and an EM component of ULF ionic currents embedded within it, respectively. On that line, the ionic condensations in the structured acupuncture system, with an EM component of ULF ionic currents embedded within it, behave like "distributed centers of consciousness" - this presumably being biophysical basis of yogic *chakras* [43].

Finally, if the EM field of ULF ionic currents represents sophisticated internal display (related to consciousness) of neural network information processing, it seems that consciousness is not privilege of humans - but can be also a characteristic of higher animals. Even more, if microtubular cytoskeletal structures have neural network-like electrical activities on subcellular level [55], it seems that consciousness can be descended down to the cellular level of animals and plants, which is supported by some experiments in a past few decades [56]. Naturally, the conscious content displayed in such EM internal displays depends on the complexity of corresponding neural network information processing at different levels, from cellular to brain ones.

Furthermore, as the EM field is presumably only one out of four manifestations (electromagnetic, gravitational, weak and strong nuclear forces) of the unified physical field [57], it can be tentatively generalized that the unified field itself may be internal conscious display for various physical processes at different structural levels, from macroscopic cosmic to microscopic subnuclear ones. As a consequence, one could conjecture that Nature itself has consciousness at different structural levels, both animate and inanimate, as it is widely claimed in traditional esoteric knowledge [40,43]. Although such nonlocal pantheistic idea of consciousness is rather bizarre, it can naturally help in resolving the fundamental problem of the wave function reduction in the quantum theory of measurement.

6. QUANTUM THEORY OF MEASUREMENT AND CONSCIOUSNESS

Consciousness as a physical phenomenon appeared for the first time at the begining of this century, with discovery of Quantum mechanics. In quantum theory of measurement there appeares the problem of the wave function reduction (collapse), where in an act of measurement (including finally the very act of conscious

observation [m] of the act of measurement) the macroscopic measuring apparatus (including consciousness as a "subjective" observer) makes reduction of the initial wave function into one of the possible eigenfunctions of the system.

The problem of the wave function reduction (collapse) in an act of measurement is "ortodoxly" interpreted in quantum theory of measurement [58] as the discontinuous change induced by the observation of a quantity with eigenstates Ψ_1, Ψ_2,..., in which the initial wave function $\Psi = \sum_i a_i \Psi_i$ will be changed to the state Ψ_j with probability $|a_j|^2$. The collapse of the wave function and the assignment of statistical probabilities do not follow from the Schrödinger equation - they are consequences of an external *a priori* metaphysics, which is allowed to intervene at this point and suspend the Schrödinger equation, or rather replace the boundary conditions on its solution by those of the collapsed state function.

The problem of quantum theory of measurement has not been consistently resolved to date, and has been the subject of many serious theoretical efforts, from the very beginning of Quantum mechanics [58-60].

On the other hand, Quantum mechanics is *nonlocal theory*, as even very distant parts of quantummechanical system (which cannot exchange light signals) can be physically correlated in the act of measurement (like in Einstein-Podolsky-Rosen paradox [59]). As an extreme consequence, this implies that consciousness as a "subjective" observer in such kind of experiment must have *nonlocal properties*.

The property of *nonlocality* of consciousness is *automatically fullfiled* in our relativistic biophysical model, according to which consciousness is inherently and globally related to the very *electromagnetic field* of the brainwaves ionic currents! Having in mind that EM field is only one of the four manifestations of the unified physical field [57] - it might be that the very *unified field* is global (nonlocal) internal conscious display for various physical processes at different structural levels, from microscopic to macroscopic ones. This bizarre nonlocal pantheistic idea of consciousness can naturally help in resolving the *fundamental difficulties* of the *wave function reduction*, as stated below.

In one of the most recent approaches, Penrose proposes gravitationally induced wave function reduction [60]. Actually, the gravitational field of measuring apparatus, with all possible measuring outputs, must be also involved in the above superposition of quantum eigenstates - this implying different space-time geometries

---

[m] Radical proponents of such a standpoint were von Neumann [58] and Wigner [59]. One should mention also the paradox of Schrödinger's cat [59], with cat in a closed box equipped with radioactive α-source, whose α-emitting activates a chemical poison in the box. The cat's state ("cat dead" or "cat alive") depends not only of statistical activity of radioactive decay of the α-source, but of the very observational act of conscious observer after opening the box: until this very point, the cat was in the quantummechanical limbo of simultaneous combination of "cat dead" and "cat alive", with different relative probabilities depending on the probability for α-decay of the radioactive source.

superimposed. However, when the geometries become sufficiently different (on the Planck-Wheeler scale ~ 10^{-35} m), thus implying ill-defined standard superposition of the *matter* eigenfunctions in strictly *separate* spaces - Nature must choose between one of them and *actually* effects wave function reduction.[n)]

As an opposite extreme in interpretation of the act of quantum measurement, Everett's many-worlds interpretation of Quantum mechanics [59] proposes that no collapse of initial wave function is happening in the process of measurement, but that there exists splitting of the composed initial state, consisted of initial state Y and the apparatus state Φ, into the superposition of all possible composed states, consisted of eigenstates Ψ_i and corresponding observers states Φ_i, $\Psi\Phi \rightarrow \sum_i a_i\Psi_i\Phi_i$ - each element of the resulting superposition describing an observer who perceived a definite and generally different result, and to whom it appears that the initial state Ψ has been transformed into the corresponding eigenstate (Ψ_j, if particular observer's state is Φ_j). In this sense the "popular" assertion of the wave function reduction appear to hold on a subjective level to each observer described by an element of the superposition. The price to be paid for physical consistency - is the splitting of the initial system into many copies with different eigenstates, existing simultaneously further on.

Actually, all that consistently applies to the whole Universe, which is constantly splitting into a stupendous number of branches, all resulting from the measurement-like interactions between its myriads of microparticles. In the context of our biophysical model of consciousness, different "subjective" states of delocalized "cosmic consciousness" can be related with corresponding observers states Φ_i - associated with corresponding cosmic eigenstates Ψ_i, with different probabilities $|a_i|^2$.

[n)] The completely consistent physical picture of such a process (related to Planck-Wheeler scale) should be sought in future quantum gravity theory [60]. One of particular approaches to quantum gravity was confronted with computationally unsolvable topological equivalence problem for 4-dimensional space-time geometries, which is then related with ill-defined decomposition of quantum-gravitational state on superposition of all possible space-time geometries. The another related problem is that in such quantum-gravitational superposition one must superimpose, alongside the "reasonable" space-time geometries in which time behaves fairly sensibly, "unreasonable" space-times in which there are closed timelike lines (time travel in own past; it should be noted that such solutions are obtained from classical Einstein's gravitational equations too, as so called wormholes or Einstein-Rosen space-time bridges, mentioned in previous section [47]). Such bizarre space-time geometries are acausal (the cause and consequence exchange their roles!), and hence cannot be algorithmically simulated [60]. As, according to Penrose, the solving of quantum measurement problem is prerequisite for an understanding of consciousness, the consciousness itself cannot be algorithmically simulated (which is additionally supported by Gödel-Turing argument that human understanding and creativity cannot be modeled by Turing machine, i.e. they cannot be reduced to computer algorithm) [60]. However, this does not necessarily mean that future brain-like computers with artificial consciousness are not possible: they can be based on biophysical principles we human beings are functioning, but they certainly will not be similar to contemporary algorithmic computers.

It should be noted that physical interaction of the displaced gaseous ionic "optical" neural network with *possible* "objective" system (described by wave function Ψ_i) or corresponding *possible* state of "cosmic consciousness" (Φ_i), in "astral projections" during transitional states of consciousness - opens a question on the nature of wave functions - which should provide a picture of quantum-level physical *reality* (not only serving as a calculational device, useful merely for calculating probabilities, or as an expression of the experimenter's "state of knowledge" concerning physical system)! Then by changing initial state of "cosmic consciousness" (Φ) one can influence probabilities of realization of corresponding states Φ_i, i.e. cosmic states Ψ_i. As the state of "cosmic consciousness" (Φ) is a composite state constituted of (noninteracting) states of all "individual consciousness" (φ_k), $\Phi \sim \prod_k \varphi_k$, it follows that the change of state φ_k of "individual consciousness" can affect the state Φ of "cosmic consciousness", and therefore the probabilities for realization of cosmic states Ψ_i. This is particularly true if the state Φ is very sensitive on small changes of initial conditions, which is the case for physical systems described by deterministic chaos [61]. Having in mind that the brain and corresponding state φ_k of "individual consciousness" is such kind of system, then the composite state Φ of "cosmic consciousness" is also described by deterministic chaos - and therefore very sensitive on small changes in initial conditions! Such a conclusion implies extraordinary practical significance of moral and contents of our "individual consciousness", as they directly determine the probability of realization of cosmic states Ψ_i, i.e. the future events, no matter how bizarre this conclusion looks like (see also the footnote j)!

Moreover, as microparticles are continuously subjected to fantastic accelerations ($\sim v^2/r \sim 10^{23}$ m/s^2 for electrons bounded in atoms, and $\sim 10^{29}$ m/s^2 for protons and neutrons bounded in nucleus,...), which can be met also in extremely strong gravitational fields - according to the Principle of equivalence one should expect continuous opening and closing of local Einstein-Rosen bridges, addresses of their exits being related (probabilistically) to one of the possible eigenstates of corresponding microparticles.[o)] This process might yet be the mechanism for some sort of the wave function reduction, implying why so important the *mental addressing* is in transitional states of consciousness, related to "astral projections", described above! It also reveals that Quantum mechanics and the General theory of relativity seem to be deeply interconnected on microparticle level, showing that microparticles are continuously vanishing and reemerging (subjected obviously to corresponding con-

---

[o)] The necessity for application of quantum mecanics to phenomena related to Einstein-Rosen bridges (wormholes) is also pointed out in analyses of indeterministic trajectories of classical bodies moving through a wormhole (due to possible backward mechanical influence of the body on itself, after getting out from the nearby wormhole's exit appropriately placed in the past in respect to the wormhole's entrance, for the same initial conditions there can potentially be many trajectories of the body through the wormhole, obeying classical conservation laws) - with corresponding probabilities for any of them, as in the case for quantummechanical microparticles [47]!

servation laws) in measurement-like interactions, throwing a new light on wave-particle dualism and other quantummechanical phenomena.

In that framework, the role of consciousness in quantum theory of measurement turns out to be extremely important! For instance, in gravitationally induced wave function reduction, the very mechanism for this process could be continuous opening and closing of local microparticles' Einstein-Rosen bridges, addresses of their exits being related (probabilistically) to one of the possible eigenstates of corresponding microparticles - and everything being related to corresponding probabilistic addressing of delocalized "cosmic consciousness" (including the state of the measuring apparatus). On the other hand, in the framework of many-worlds interpretation of quantum mechanics, many different local Einstein-Rosen bridges could be simultaneously created, related to corresponding observer's states Φ_i of delocalized "cosmic consciousness" - associated with corresponding world's eigenstates Ψ_i. [p)]

7. PROPOSED EXPERIMENTAL TESTS

It should be noted that psychological tests on subjective time sense distortions in altered states are not sufficiently distinctive, being affected by at least two effects: (a) amount and complexity of the processed and memorized stimuli (limited by "channel capacity" of conscious information processing, of one piece of information per ~ 0.1 s) [62], and (b) the relativistic model for dilations of the subjective time base, i.e. "channel capacity" (influenced by change in ε_r from $\varepsilon_r >> 1$ to $\varepsilon_r \approx 1$).

However, there are still some possible tests of our model:

(1) The insufficient change in the biochemical rate of neurotransmitter secretion in altered states in comparison to normal alert state can be tested by positron emission to-

---

[p)] Which of these opposite viewpoints will turn out to be closer to reality is not at all clear. However, my personal feeling is closer to the first viewpoint, with gravitationally induced wave function reduction of the kind described above, where adjustment of the state Φ of "cosmic consciousness" to one of its eigenstates Φ_i, during the measurement-like process on cosmic scale, raises the corresponding probability $|a_i|^2$ to 1, while diminishing the others - by creating corresponding local microparticles' Einstein-Rosen bridges throughout the Universe, giving rise to existence the cosmic state described by corresponding wave function Ψ_i. What is actually anticipated in transitional states of "individual consciousness" might be the evolved state $\Phi(t)$ in some future moment t (to which our "individual consciousness" has access, being the constitutional part of "cosmic consciousness"), which is quantummechanicaly described by deterministic unitary evolution governed by Schrodinger equation (or Dirac equation in relativistic case). However, the anticipated state $\Phi(t)$ could be redefined by changing initial state φ_i of "individual consciousness", leaving room for *free will* and the possibility for influence on the future. In this respect, it is quite possible that strong *preferences* in individual or collective futures exist, governed by karmical interpersonal loads, as it is claimed in Eastern tradition [48]. On the same line, it might be also possible that karmical cleansing (by prayer or some other esoteric technic) is the efficient mechanism for changing initial state of several (karmically) related "individual consciousness" [53,54].

mography. This can demonstrate insufficiency of purely biochemical methods, and the necessity of adopting the proposed biophysical method, in explaining the striking acceleration of conscious information processing in altered states in respect to normal ones.

(2) The detection of the low-dielectric ionic structure, partly displaced from the body in the altered states of consciousness, is possible by monitoring the local change in the ionic concentration (from 10^4 to 10^{15} cm^{-3}) in the vicinity of the body, by using infrared image processing, microwave scattering, electro-photography, positron emission tomography or some other isotope tracer studies.

(3) The information coding from neural network to brainwaves can be tested on artificial or biological neural networks with embedded ULF electric activity. It is only necessary to learn the network to some complex stimuli, or conditioned reflex in the case of living organisms. If this information is simultaneously coded in ULF electric activity, it can be transferred to neighbor equivalent neural network due to electromagnetic induction coupling. This could demonstrate the possibility for neural network-brainwave coding and vice versa, as well as the mechanism of short-range transpersonal interactions.

(4) Transpersonal long-range EM ULF biophysical interactions predicted by the model can be tested between the close persons with synchronized 90-120 min-ultradian rhythms, at the end of phases of altered states of consciousness.

(5) On the contrary, the predicted transcendence of space-time relations in precognitive or clairvoyant (acausal) phenomena, with non-EM ULF wave transmission, can be tested during the short phases of interchange of normal and altered states of consciousness.

8. CONCLUSION

Our biophysical analysis of the serial conscious psychological mode in normal and altered states of consciousness, implies that consciousness is subtle internal display in the form of electromagnetic component of ULF brainwave ionic currents. An additional low-dielectric ($\varepsilon_r \approx 1$) weakly ionized gaseous neural network is necessary in these processes, with the possibility of partial displacement from the body, and subsequent deterioration.

This can emulate many of the altered states of consciousness described by traditional esoteric knowledge, and reveals the probable biophysical nature of dreams, yoga goals, qi, subtle body, causal body, short-range and long-range transpersonal EM ULF interactions, and anticipating and clairvoyant acausal abilities of psyche - in the framework of the proposed theoretical model.

The model also implies that consciousness, space, time, and structure of matter might be much more deeply interconnected than it was recognized by contempo-

rary science - quite contrary to ancient civilizations, which realized and exploited that on purely empirical grounds.

It should be finally pointed out that the above successes of the model provide a possibility to incorporate consciousness inside an extended scientific paradigm. The extended paradigm might have great influence on the fundamentals of neuroscience, psychology, medicine, biology, physics and computer sciences, with significant philosophical and religious implications.

Acknowledgments: *The author would like to thank his colleagues and/or collaborators, Professors Dj.Koruga, Ž.Martinović, L.A.Gribov, Y.Omura, and R.Jahn, and Doctors G.Stanojević and B.Dunne for inspiring suggestions.*

REFERENCES

[1] B.J.Baars, *A Cognitive Theory of Consciousness* (Cambridge Univ. Press, Cambridge, MA, 1988).

[2] K.R.Poper and J.C.Eccles, *The Self and Its Brain* (Springer, Berlin, 1977), Chs. E2,8; cf. also V.Desimirović, Biological basis of consciousness, this book.

[3] E.R.John, Switchboard versus statistical theories of learning and memory, *Science* 177 (1972), pp. 850-864; E.R.John, T.Yang, A.B.Brill, R.Young, and K.Ono, Double-labeled metabolic maps of memory, *Science* 233 (1986), pp. 1167-1175.

[4] R.Eckhorn, R.Bauer, W.Jordan, M.Brosch, W.Kruse, M.Munk, and H.J.Reitboeck, Coherent oscillations: A mechanism of feature linking in the visual cortex*?, Biol. Cybern.* 60 (1988), pp. 121-130; C.M.Gray, P.Konig, A.K.Engel, and W.Singer, Oscillatory responses in visual cortex exhibit inter-columnar synchronization which reflects global stimulus properties, *Nature* 338 (1989), pp. 334-337; M.P.Stryker, Is grandmother an oscillation?, *ibid*., pp. 297-298; F.Crick and C.Koch, Towards a neurobiological theory of consciousness, *Seminars in the Neurosciences* 2 (1990), pp. 263-275;

[5] F.Crick, *The Astonishing Hypothesis. The Scientific Search for Soul* (Charles Scribner's Sons, New York, and Maxwell Macmillan International, 1994).

[6] D.Raković, Biocomputers - the perspectives, *Proc. 15th Yug.Conf. Microelectr.* (MIEL-87), pp. 143-146 (1987), in Serbian; D.Raković, Đ.Koruga, D.Djaković, Ž.Martinović, V.Desimirović, and Dj.Minić, Ultralowfrequency "optical" biocomputers: Biophysical arguments, in F.Hong, ed., *Molecular Electronics: Biosensors and Biocomputers* (Plenum, New York, NY, 1989), pp. 397-405; D.Raković, Đ.Koruga, Ž.Martinović, and G.Stanojević, Molecular electronics and neural networks: Significance of ionic structure, *Proc. Ann. Int. Conf. IEEE/EMBS* 11, pp. 1366-1367 (1989),

Y.Kim and F.A.Spelman, eds., Part 4/6; D.Raković, Đ.Koruga, Ž.Martinović, and G.Stanojević, On biophysical structure of brainlike biocomputers, in P.I.Lazarev, ed., *Molecular Electronics: Materials and Methods* (Kluwer, Dordrecht, The Netherlands, 1991), pp. 211-217; D.Raković, Perspectives for brain-like computers: Modeling of altered states of consciousness, *Info* 1 (1993), pp. 17-22, in Serbian; D.Raković, Towards theoretical psychology: Hierarchical neural networks and brainwaves, *Info* 3 (1994), pp. 2-8, in Serbian.

[7] D.Raković, Neural networks, brainwaves, and ionic structures: Acupuncture vs. altered states of consciousness, *Acup. & Electro-Therap. Res., Int. J.* 16 (1991), pp. 89-99; D.Raković, Neural networks vs. brainwaves: Prospects for cognitive theory of consciousness, *Proc. Ann. Int. Conf. IEEE/EMBS* 12, pp. 1431-1432 (1990), P.C.Pedersen and B.Onaral, eds., Part 3/5; D.Raković, A cognitive theory of consciousness: Possible educational framework, *ibid*., pp. 2373-2374, Part 5/5; D.Raković, Neural networks versus brainwaves: A model for dream-like states of consciousness, *Proc. Ann. Int. Conf. IEEE/EMBS* 14, pp. 2651-2652 (1992), J.P.Morucci, R.Plonsey, J.L.Coatrieux, S.Laxminarayan, eds., Part 6; D.Raković, Neural networks versus brainwaves: Biophysical model for ELF interactions, *ibid*., pp. 2750-2751 (1992); D.Raković, Neural networks, brainwaves, and ionic structures: Biophysical model for states of consciousness, *Int. Conf. Toward a Scientific Basis of Consciousness* (Tucson, April 12-17, 1994).

[8] D.Raković, *Fundamentals of Biophysics* (Grosknjiga, Belgrade, 1994), Chs. 5,6.

[9] W.R.Adey, Tissue interactions with nonionizing electromagnetic fields, *Physiol. Rev.* 61 (1981), pp. 435-514, and references therein.

[10] In C.Tart, ed., *Altered States of Consciousness* (Academic, New York, 1972).

[11] E.Basar, EEG-dynamics and evoked potentials in sensory and cognitive processing by the brain, in E.Basar, ed., *Dynamics of Sensory and Cognitive Processing by the Brain* (Springer, Berlin, 1988), pp. 30-55; *ibid*., Thoughts on brain s internal codes, pp. 381-384.

[12] E.Basar, *EEG Brain Dynamics* (Elsevier, Amsterdam, 1980), Ch. 2.

[13] D.Foulkes, Theories of dream formation and recent studies of sleep consciousness, *Psychol. Bull.* 62 (1964), pp. 236-247; *Ref.* 10, Sect. 3

[14] L.D.Landau and E.M.Lifschics, *Field Theory* (Nauka, Moscow, 1973), Ch. 9, in Russian.

[15] T.H.Budzynski, Clinical applications of non-drug-induced states, in B.B.Wolman and M.Ullman, eds., *Handbook of States of Consciousness* (Van Nostrand Reinhold, New York, NY, 1986), pp. 428-460.

[16] C.T.White, Temporal numerosity and the psychological unit of duration, *Psychol. Monogr.* 575 (1963); J.M.Stroud, The fine structure of psychological time, in R.Fischer, ed., *Interdisciplinary Perspective of Time*, Ann. NY Acad. Sci. 138 (1967).

[17] *Ref.* 10, Sect. 3.

[18] M.H.Erickson and L.F.Cooper, *Time Distortion in Hypnosis* (Williams & Wilkins, Baltimore, 1959); *Ref.* 10, Sect. 5.

[19] *Ref.* 10, Sect. 4.

[20] *Ref.* 10, Sects. 6,7.

[21] K.Jaspers, *Algemaine Psychopathologie* (Springer, Berlin, 1953).

[22] R.A.Moody, jr., *Life after Life* (Bantam, New York, NY, 1975); M.Sobom, *Recollections of Death, A Medical Investigation* (Harper & Row, New York, 1982).

[23] *Ref.* 14, Ch. 1; E.F.Taylor and J.A.Wheeler, *Spacetime Physics* (Freeman, San Francisco, CA, 1963), Ch. 1 (Ex. 10), Ch. 2 (Ex. 56).

[24] W.James, The scope of psychology, in R.E.Ornstein, ed., *The Nature of Human Consciousness* (Freeman, San Francisco, CA, 1973), pp. 6-12, reprinted from W.James, *The Principles of Psychology* (1890), I, (Dover, New York, NY, 1950).

[25] L.D.Landau and E.M.Lifschics, *Electrodynamics of Continuous Media* (Nauka, Moscow, 1982), Ch. 9, in Russian.

[26] *Ref.* 14, Ch. 6.

[27] *Ref.* 10, Sect. 8.

[28] R.Hecht-Nielsen, *Neurocomputing* (Addison-Wesley, New York, NY, 1990).

[29] D.Raković, *Physical Fundamentals and Characteristics of Electroengineering Materials* (Faculty of Electrical Engineering, Belgrade, 1995), Ch. 6, in Serbian; such data can be found in many textbooks on physics and materials science.

[30] F.F.Chen, *Introduction to Plasma Physics* (Plenum, New York, NY, 1974), Ch. 3.

[31] L.D.Landau and E.M.Lifschics, *Statistical Physics* (Nauka, Moscow, 1976), Ch. 3, in Russian.

[32] P.L.Nunez, *Electric Fields of the Brain* (Oxford Univ. Press, New York, NY, 1981), Ch. 6.

[33] *Ref.* 30, Ch. 9.

[34] F.Reif, *Statistical Physics*, Berkeley Physics Course, Vol. 5 (Mc Graw Hill, San Francisco, CA, 1967), Ch. 8.

[35] A.P.Krueger, Preliminary consideration of the biological significance of air ions, *Scientia* 104 (1969), pp. 1-17.

[36] R.Broughton, Human consciousness and sleep/waking rhythms, in B.B.Wolman and M.Ullman, eds., *Handbook of States of Consciousness* (Van Nostrand Reinhold, New York, NY, 1986), pp. 461-484.

[37] R.G.Jahn, The persistent paradox of psychic phenomena: An engineering perspective, *Proc. IEEE* 70 (1982), pp. 136-170; V.P.Kaznacheev, A.V.Trofimov, *Cosmic Consciousness of Humanity* (Elendis-Progress, Tomsk, Russia, 1992).

[38] H.L.König, ELF and VLF signal properties: Physical characteristics, in M.A.Persinger, ed., *ELF & VLF Electromagnetic Effects* (Plenum, New York, NY, 1974).

[39] R.Sheldrake, *A New Science of Life* (Paladin Grafton, London, 1987).

[40] J.S.Hagelin, Is consciousness the unified field? A field theorist's perspective, *Modern Science and Vedic Science* 1 (1987), pp. 29-88, and references therein.

[41] C.G.Jung, *Man and His Symbols* (Dell Publ., New York, 1972).

[42] C.W.Misner, K.S.Thorne, and J.A.Wheeler, *Gravitation* (Freeman, San Francisco, 1973), Ch. 22.

[43] K.Wilber, *The Atman Project* (Quest, Wheaton, IL, 1980), and references therein; cf. also P.Vujičin, States of consciousness in esoteric practice, this book.

[44] S.Alberts, D.Bray, J.Lewin, M.Raff, K.Roberts, and J.D.Watson, Molecular *Biology of the Cell* (Garland, New York, NY, 1983), Ch. 6.

[45] E.L.Rossi, Altered States of Consciousness in Everyday Life: Ultradian Rhythms, in B.B.Wolman and M.Ulman, eds., *Handbook of States of Consciousness* (Van Nostrand Reinhold, New York, NY, 1986), pp. 97-132.

[46] E.F.Taylor and J.A.Wheeler, *Spacetime Physics* (Freeman, San Francisco, CA, 1963), Ch. 1 (Exs. 27,49).

[47] K.S.Thorne, *Black Holes and Time Warps: Einstein's Outrageous Legacy* (Picador, London, 1994), Ch. 14, and references therein.

[48] W.Evans Wentz, *The Tibetan Book of the Dead* (Oxford Univ., London, 1968).

[49] D.I.Radin, Effects of A Priori Probability on PSI Perception: Does Precognition Predict Actual or Probable Futures, *J. Parapsych*. 52 1988), pp. 187-212.

[50] F.G.Portnov, *Electropuncture Reflexotherapeutics* (Zinatne, Riga, 1982), Ch. 4, in Russian.

[51] B.Pomeranz, Acupuncture research related to pain, drug addiction and nerve regeneration, in B.Pomeranz and G.Stux, eds., *Scientific Bases of Acupuncture* (Springer, Berlin, 1989), pp. 35-52.

[52] Y.Omura, T.L.Lin, L.Debreceni, B.M.Losco, S.Freed, T.Muteki, and C.H.Lin, Unique changes found on the qi gong (chi gong) master's and patient's body during qi gong treatment: Their relationships to certain meridians & acupuncture points and the recreation of therapeutic qi gong states by children & adults, *Acupuncture & Electro - Therap. Res., Int. J.* 14 (1989), pp. 61-89.

[53] K.C.Markides, *Fire in the Heart. Healers, Sages and Mystics* (Paragon House, New York, 1990).

[54] Swami Rama, *Living with the Himalayan Masters* (Himalayan Int. Inst. of Yoga Sci. & Phil., Honesdale, PA, 1978).

[55] S.R.Hameroff, *Ultimate Computing. Biomolecular Consciousness and Nanotechnology* (North-Holland, Amsterdam, 1987); Đ.Koruga, Molecular networks as a sub-neural factor of neural networks, *BioSystems* 23 (1990), pp. 297-303.

[56] R.B.Stone, *The Secret Life of Your Cells* (Whitford Press, West Chester, PA, 1989).

[57] J.H.Schwarz, Superstrings, *Physics Today*, Nov.1987, pp. 33-40, and references therein.

[58] J.von Neumann, *Mathematical Foundations of Quantum Mechanics* (Princeton Univ. Press, Princeton, 1955), Ch. 6.

[59] In J.A.Wheeler and W.H.Zurek, eds., *Quantum Theory and Measurement* (Princeton Univ., Princeton, NJ, 1983).

[60] R.Penrose, *Shadows of the Mind, A Search for the Missing Science of Consciousness* (Oxford Univ., Oxford, 1994), Part II, and references herein.

[61] A.Babloyantz, Chaotic dynamics in brain activity, in E.Basar, ed., *Dynamics of Sensory and Cognitive Processing by the Brain* (Springer, Berlin, 1988), pp. 196-202; J.Roschke and E.Basar, The EEG is not a simple noise: strange attractors in intracranial structures, *ibid*., pp. 203-216; cf also V.Radivojević, M.Rajković, D.Timotijević, and M.Car, Deterministic chaos in EEG signal, this book.

[62] R.E.Ornstein, *On the Experience of Time* (Penguin, New York, 1969).