Hierarchic Model of Consciousness
from molecular Bose condensation to synaptic reorganization

Alex Kaivarainen

Abstract
Hierarchic Model of Consciousness, proposed in this work, is based on Hierarchic Theory of Matter and Field, developed by the author, its application to properties of water in microtubules (MT) and distant exchange electromagnetic interaction between MT. The evidence, based on our theory and Virial theorem, are considered, pointing to possibility of mesoscopic (intermediate between macroscopic and microscopic) molecular Bose condensation in any condensed matter. It is shown also, that conditions of nonlocality coincide with conditions of macroscopic Bose condensation, real in condensed matter and virtual in the Vacuum).

In accordance to our Hierarchic Model of Consciousness (HMC), each specific kind of neuron ensembles excitation - corresponds to hierarchical system of three-dimensional (3D) standing waves of following interrelated kinds: thermal de Broglie waves (waves B), produced by anharmonic translations and librations of molecules; electromagnetic (IR) waves; acoustic waves (thermal phonons) and vibro-gravitational waves. Corresponding complex hologram may be responsible not only for quantum neurodynamics regulation, but for morphogenetic field also.

In our model we consider corresponding quantum collective excitations, resulted from coherent anharmonic translational and librational oscillations of water molecules in the hollow core of the microtubules. This water fraction is most organized and orchestrated fraction of condensed matter in cells. The mechanism suggested, needs the existence the following hierarchical stages of each elementary act of perception and memory, as a consequence of simultaneous excitation and depolarization of big enough number of interacting quantum mechanically and classically neurons, forming cooperative ensemble:
1. The change of the electric field tension in the neuron's body, as a result of membranes depolarization,
2. Opening the potential dependent Ca\textsuperscript{2+} channels and increasing the concentration of these ions in cytoplasm. Activation of Ca\textsuperscript{2+} - dependent protein gelsolin, which stimulate fast disassembly of actin filaments;
3. Shift of A ⇄ B equilibrium between the closed (A) and open to water (B) states of cleft, formed by α and β tubulins in tubulin pairs of microtubules (MT) to the right as a consequence of piezoelectric effect, induced by depolarization,
4. Increasing the life-time and dimensions of coherent "flickering" water clusters in MT, representing the 3D superposition of de Broglie standing waves (primary librational effectons) of H\textsubscript{2}O molecules in hollow core of MT. It is a result of the water molecules immobilization by 'open' nonpolar clefts of (αβ) dimers in MT,
5. Increasing the superradiance of coherent IR photons induced by synchronization of quantum transitions of the effectons between acoustic and optic like states. Corresponding increasing of...
probability of superdeformons (cavitational fluctuations) excitation in water of cytoplasm,
6. The disassembly of actin filaments system to huge number of subunits, [gel → sol] transition and increasing of water fraction in hydration shell of proteins. It is a result of cavitational fluctuations and destabilization of actin filaments by Ca$^{2+}$. These events decrease the water activity in cytoplasm and increase strongly the passive osmotic diffusion of water from the external volume to the cell.
7. As a consequence of previous stage, a jump-way increasing of the nerve cell body volume (pulsation), accompanied by disrupting the (+) ends of MTs with cytoplasmic membranes occurs. This stage makes MTs possible to change their orientation inside neuron's body.
8. Spatial “tuning”-collective reorientation of MTs of simultaneously excited neurons to geometry, corresponding to minimum potential energy of distant (but not nonlocal) electromagnetic and vibro-gravitational interaction between MTs and centrioles twisting.
9. Decreasing the concentration of Ca$^{2+}$ to the critical one, when disassembly of actin filaments is stopped and [gel-sol] equilibrium shifts to the left again, stabilizing the new MTs system spatial configuration, the nerve cell body volume and geometry. This new geometry of nerve cells after fixation of (+) ends of MTs back to plasmatic membrane - determines the new distribution of ionic channels activity and reorganization of synaptic contacts in all excited ensemble of neurons after relaxation, i.e. short-term and long-term memory.

The Brownian effects, which influence reorientation of MTs system and probability of cavitational fluctuations, stimulating [gel-sol] transition in nerve cells-represent in our model the non-computational element of consciousness. Other models relate this element to wave function collapse.

The proposed elementary act of consciousness was used in our theory of Quantum Psi Phenomena, Based on Unified Theory of Bivacuum, Particles Duality, Fields & Time.

Key Words: consciousness, microtubules, non-computational, quantum computation, gel-sol, consciousness model, hierarchic model of consciousness

I. INTRODUCTION
A basically new hierarchic quantitative theory, general for solids and liquids, has been used as a background of quantum features of our Hierarchic model of consciousness. It is assumed in theory, which anharmonic oscillations of particles of condensed matter lead to emergence of three-dimensional (3D) superposition of standing de Broglie waves of molecules, electromagnetic and acoustic waves. Consequently, any condensed matter could be considered as a gas of 3D standing waves of corresponding nature. Our approach unifies and develops the Einstein's and Debye's models.

Collective excitations in form of coherent clusters, representing at certain conditions the mesoscopic molecular Bose condensate, were analyzed. It was shown, that the real most probable de Broglie wave length can exceed the classical thermal de Broglie wave length and the distance between centers of molecules many times. This makes possible the atomic and molecular partial Bose condensation in solids and liquids at temperatures, below boiling point. It is one of the most important results of new theory, which was confirmed by computer simulations on examples of water and ice.
Four strongly interrelated new types of quasiparticles (collective excitations) were introduced in our hierarchic model:

1. Effectons (tr and lb), existing in "acoustic" (a) and "optic" (b) states represent the coherent clusters in general case; 2. Convertons, corresponding to interconversions between tr and lb types of the effectons (flickering clusters); 3. Transitons are the intermediate $[a \leftrightarrow b]$ transition states of the tr and lb effectons; 4. Deformons are the 3D superposition of IR electromagnetic or acoustic waves, activated by transitons and $[lb \leftrightarrow tr]$ convertons.

Primary effectons (TR and lb) are formed by 3D superposition of the most probable standing de Broglie waves of the oscillating ions, atoms or molecules. The volume of effectons (TR and lb) may contain from less than one, to tens and even thousands of molecules. The first condition means validity of classical approximation in description of the subsystems of the effectons. The second one points to quantum properties of coherent clusters due to molecular Bose condensation. In the general case the effecton can be approximated by parallelepiped with edges corresponding to de Broglie waves length in three selected directions (1, 2, 3), related to the symmetry of the molecular dynamics. In the case of isotropic molecular motion the effecton shape may be approximated by cube.

The in-phase oscillations of molecules in the effectons correspond to the effecton's (a) - acoustic state and the counterphase oscillations correspond to their (b) - optic state. States (a) and (b) of the effectons differ in potential energy only, however, their kinetic energies, impulses and spatial dimensions - are the same. The b-state of the effectons has a common feature with Fröhlich's polar mode.

The $(a \rightarrow b)$ or $(b \rightarrow a)$ transition states of the primary effectons (tr and lb), defined as primary transitons, are accompanied by a change in molecule polarizability and dipole moment without density fluctuation. In this case the transitions lead to absorption or radiation of IR photons, respectively.

Superposition (interception) of three internal standing IR photons, penetrating in different directions (1, 2, 3) - forms primary electromagnetic deformons (tr and lb). On the
other hand, the [lb =\rightarrow tr] convertons and secondary transitons are accompanied by the density fluctuations, leading to absorption or radiation of phonons. Superposition resulting from interception of standing phonons in three directions (1,2,3) forms secondary acoustic deformons (tr and lb).

Correlated collective excitations of primary and secondary effectons and deformons (tr and lb), localized in the volume of primary tr and lb electromagnetic deformons, lead to origination of macroeffectons, macrotransitons and macrodeformons (tr and lb respectively).

Correlated simultaneous excitations of tr and lb macroeffectons in the volume of superimposed tr and lb electromagnetic deformons lead to origination of supereffectons.

In turn, the coherent excitation of both: tr and lb macrodeformons and macroconvertons in the same volume means creation of superdeformons. Superdeformons are the biggest (cavitational) fluctuations, leading to microbubbles in liquids and to local defects in solids.

Total number of quasiparticles of condensed matter equal to 4!=24, reflects all of possible combinations of the four basic ones [1-4], introduced above. This set of collective excitations in the form of "gas" of 3D standing waves of three types: de Broglie, acoustic and electromagnetic - is shown to be able to explain virtually all the properties of all condensed matter. Our theory is confirmed quantitatively by mean of computer simulations on examples of water and ice. It was used for explanation of different phenomena of quantum neurodynamics (Kaivarainen 1996, 1998).

The electrical recording of human brain activity demonstrate a coherent (40 to 70 Hz) firing among widely distributed and distant brain neurons (Singer, 1993). Such synchronization in a big population of groups of cells points to possibility of not only regular axon-mediated, but also of physical fields-mediated distant or even quantum nonlocal interaction between them.

The idea of Karl Pribram (Languages of the Brain, 1977) of holographic principles of memory and braining is very popular in quantum models of consciousness. We also support this general idea and try to transform it in concrete shape in our model. In contrast to usual
holograms, reflecting the three-dimensional geometric properties of objects in photo materials, the information in the membranes and cytoskeleton of nerve cells is encoded in the form of our effectons and deformons, introduced in our Hierarchic theory of condensed matter (Kaivarainen 1995; 2000).

The code way of keeping the information in the form of the effectons and deformons as 3D standing waves (de Broglie waves, electromagnetic, acoustic and vibro-gravitational), generated by microtubules, containing internal water, much more organized than bulk water and water of cytoplasm - looks very effective and may be used at quantum computer technology.

Hameroff and Penrose (1996a,b; 1998) proposed the "orchestrated objective reduction (Orch OR)" model of quantum computation in microtubules (MT) of brain. They suppose, that quantum nonlocal interaction between huge number of MT may provide coherency of their thermal dynamics. Based on principle of uncertainty in coherent form it was calculated, that if the difference in volume of alternative states of very big dynamically coherent number ($10^9$) of tubulin dimers ($\alpha\beta$) is about 10% during 0.5s (arbitrary assumption), the quantum gravity induced self-collapse to one of such state may occur. However, even accepting these calculations as valid, their model do not explain the following crucial moments:

a) the physical mechanism of nonlocality, providing distant thermal and quantum coherency in MTs and its switching on and off;

b) the selectivity of this mechanism, working just for tubulins and not for other proteins of cell (i.e. nature of selective quantum nonlocality);

c) the biophysical bridges between nerve excitation, self-collapsing of MTs system to one state and synaptic reorganization.

The only way to 'save' the idea of Penrose and Hameroff about quantum gravity induced self-collapse of MTs system is to suppose that collapse may be resulted from change of mass of fraction of mesoscopic Bose condensation of water molecules in hollow core of microtubules, triggered by membranes depolarization, in accordance to our model.
It follows from our theory and computer simulations, that mesoscopic Bose condensate of water may exist even at physiological temperature in form of coherent molecular clusters (primary librational effectons). The size of such clusters are determined by 3-dimensional (3D) standing de Broglie waves of molecules, related with their librations.

Mesoscopic molecular Bose condensation at physiological temperature: possible or not? The existence of mesoscopic (intermediate between microscopic and macroscopic) Bose condensation in form of coherent clusters in condensed matter (liquid and solid) at the ambient temperature was rejected for a long time. The reason of such shortcoming was a wrong primary assumption, that the thermal oscillations of atoms and molecules in condensed matter are harmonic ones (Beck and Eccles, 1992). The condition of harmonic oscillations means that the averaged kinetic ($T_k$) and potential ($V$) energy of molecules are equal to each other and linearly dependent on temperature ($T$).

This condition leads from Virial theorem (Clausius, 1870) for the case of classical system:

\[ T_k = V = \frac{1}{2} kT \]

where: \( k \) is a Boltzmann constant.

The averaged kinetic energy of the oscillating particle may be expressed via its averaged impulse (\( p \)) and mass (\( m \)):

\[ T_k = \frac{p^2}{2m} \]

The average or most probable wave B length (\( \lambda_B \)) of such particle, following from wrong assumption of harmonic oscillations of molecules in condensed matter (1.1), is:

\[ \lambda_B = \frac{h}{p} = \frac{h}{\sqrt{mkT}} \]

It is easy to calculate from this formula, that around the melting point of water \( T=273K \) the most probable wave B length of water molecule at the assumption (1.1) in liquid and
solid state is less than $1\text{Å}$ and much less than the distance between centers of molecules ($3\text{Å}$). This result leads to wrong conclusion, that water and ice are classical systems.

It is known from theory of Bose condensation (BC), that BC is possible only at conditions, when the length of waves $B$ of particles are bigger than the average distance between their centers ($l$):

$$l = (V_0/N_0)^{1/3}$$

$$L > \lambda_B > l$$

where: $L$ is a macroscopic parameter, comparable with dimensions of the whole sample.

Condition (1.5) is a condition of partial or mesoscopic Bose condensation, which in accordance to our Hierarchic theory and computer calculations are valid for all real condensed systems, including biopolymers, membranes, microtubules, actin filaments, etc. and, of course, for water—as a main component of biosystems.

Consequently, wrong assumption (1.1) leads to formula (1.3) and wrong result:

$$\lambda_B < l$$

meaning the absence of Bose condensation in any condensed matter (liquid or solid) at room temperature and its classical properties.

Logical mistake in deriving (1.3) was, that from the beginning the classical condition (1.1) was accepted as a valid. It is natural, that such assumption brings to classical result (1.6). The right way is to evaluate correctly the ratio between internal kinetic and potential energy of condensed matter or selected excitations and only after this apply to Virial theorem.

It is shown (Kaivarainen, 1995), that the structural factor ($S$) of collective excitation, which can be calculated from neutron scattering data, reflects the ratio of kinetic energy ($T_k$) to the total energy $E = V + T_k$ of quasiparticle. Consequently, if $S < 1/2$ ($V > T_k$), it points to nonclassical properties of corresponding scattering centers in accordance to Virial theorem.
The Virial theorem in general form is correct not only for classical, but as well for quantum systems. It relates the averaged kinetic \( \bar{T}(v) = \sum_i \frac{m_i v_i^2}{2} \) and potential \( \bar{V}(r) \) energies of particles, composing these systems:

\[
2\bar{T}(v) = \sum_i m_i v_i^2 = \sum_i \bar{r}_i \partial \bar{V}/\partial \bar{r}_i
\]

If the potential energy \( V(r) \) is a homogeneous \( n \)-order function like:

\[
V(r) \sim r^n
\]

then average kinetic and average potential energies are related as:

\[
n = \frac{2\bar{T}}{\bar{V}(r)}
\]

For example, for a harmonic oscillator, when \( \bar{T} = \bar{V} \), we have \( n = 2 \) and condition (1.1). For Coulomb interaction: \( n = -1 \) and \( \bar{T} = -\bar{V}/2 \). For water our hierarchic theory based computer calculations of \( \bar{T} \) and \( \bar{V} \) gives: \( n_w \sim 1/15 \) \( (\bar{V}/\bar{T}_w \sim 30) \) and for ice: \( n_{\text{ice}} \sim 1/50 \) \( (\bar{V}/\bar{T}_{\text{ice}} \sim 100) \). It follows from (1.8) and our results, that in water and ice the dependence of potential energy on distance \( r \) is very weak:

\[
V_w(r) \sim r^{(1/15)}; \quad V_{\text{ice}} \sim r^{(1/50)}
\]

Such weak dependence of potential energy on the distance can be considered as indication of long-range interaction due to the expressed cooperative properties of water as associative liquid. The difference between water and ice (1.10) points, that the role of distant Van der Waals interactions, stabilizing primary effectons (mesoscopic molecular Bose condensate), is increasing with dimensions of these coherent clusters as a result of temperature decreasing and [liquid \( \rightarrow \) solid] phase transition. It is strong evidence that
oscillations of molecules in water and ice are strongly anharmonic and the condensed matter cannot be considered as a classical system, following condition (1.1) and (1.6). Consequently, for real condensed matter we have:

$$\overline{T_k} \ll \overline{V} \text{ and } \lambda_B > l = (V_0/N_0)^{1/3}$$

It is interesting to note, that at the average kinetic energy and impulse (\(\overline{p}\)) tending to zero:

$$\overline{T_k} = \overline{p}^2/2m \to 0$$

The interaction between particles of system becomes independent on distance between them:

$$V_w(r) \sim r^{(0)} = 1 = \text{const}$$

From (1.3) and \(\overline{p} \to 0\) we came to important conclusion, that conditions of nonlocality (1.12 and 1.13) mean condition of macroscopic Bose condensation:

$$\overline{\lambda}_B = \langle h/\overline{p} \rangle \to \infty$$

Our HMC have some common features with model of Quantum Brain Dynamics (QBD), proposed by Riccardi and Umezawa in 1967 and developed by Stuart, Takahashi, Umezawa (1978, 1979), Jibu and Yasue (1992, 1993). In addition to traditional electrical and chemical factors in the nerve tissue function, this group introduced two new types of quantum excitations (ingredients), responsible for the overall control of electrical and chemical signal transfer: corticons and exchange bosons (dipolar phonons). Corticons has a definite spatial localization and can be described by Pauli spin matrices. The exchange bosons, like phonons are delocalized and follow Bose-Einstein statistics. By absorbing and emitting bosons coherently, corticons manifest global collective dynamics, providing systematized brain functioning (after Jibu and Yasue, 1993). One can find some analogy
between spatially localized corticons and our effectons as well as between exchange bosons and deformons.

II. PROPERTIES OF ACTIN FILAMENTS, MICROTUBULES AND INTERNAL WATER

There are six main forms of actin existing. Most general F-actin is a polymer, constructed from globular protein G-actin with molecular mass 41.800. Each G-actin subunit is stabilized by one ion Ca^{2+} and is in noncovalent complex with one ATP molecule. Polymerization of G-actin is accompanied by splitting of phosphate group. The velocity of F-actin polymerization is enhanced strongly by hydrolysis of ATP. However, polymerization itself does not need energy. Simple increasing of salt concentration (decreasing of water activity), approximately till to physiological one, induce polymerization and strong increasing of viscosity.

The actin filaments are composed from two chains of G-actin with diameter of 40 Å and forming double helix. The actin filaments are the polar structure with different properties of two ends. Disassembly of actin and (gel→sol) transition is dependent strongly on water activity and energy of thermal fluctuation.

Let us consider the properties of microtubules (MT) as one of the most important component of cytoskeleton, responsible for spatial organization and dynamic behavior of the cells. The stability and dynamics of microtubules composed of α and β tubulins is also dependent on water activity αn,0 (Kaivarainen 1995), concentration of Ca^{2+} and on the electric field gradient change due to MTs piezoelectric properties.

The α and β tubulins are globular proteins with equal molecular mass (MM = 55.000), usually forming αβ dimers with linear dimension 8nm. Polymerization of microtubules can be stimulated by NaCl, Mg^{2+} and GTP (1:1 tubulin monomer) (Alberts et al., 1983). The presence of heavy water (deuterium oxide) also stimulates polymerization of MT. In contrast to that the presence of ions of Ca^{2+} even in micromolar concentrations, action of colchicine and lowering the temperature till 4°C induce disassembly of MT.
Due to multigene composition, $\alpha$ and $\beta$ tubulins have a number of isoforms. For example, two-dimensional gel electrophoresis revealed 17 varieties of $\beta$ tubulin in mammalian brain (Lee et al., 1986). Tubulin structure may also be altered by enzymatic modification: addition or removal of amino acids, glycosylation, etc.

Microtubules are hollow cylinders, filled with water. Their internal diameter about $d_{in} = 140\text{Å}$ and external diameter $d_{ext} = 280\text{Å}$ (Fig. 1). These data, including the dimensions of $\alpha\beta$ dimers were obtained from x-ray crystallography (Amos and Klug, 1974). However we must keep in mind that under the conditions of crystallization the multiglobular proteins and their assemblies tends to more compact structure than in solutions due to lower water activity. This means that in natural conditions the above dimensions could be a bit bigger. The length of microtubules (MT) can vary in the interval:

$$l_{t} = (1 - 20) \cdot 10^{5}\text{Å}$$

The spacing between the tubulin monomers in MT is about 40 Å and that between $\alpha\beta$ dimers: 80 Å are the same in longitudinal and transversal directions of MT.

Each $\alpha\beta$ dimer is a dipole with negative charges, shifted towards $\alpha$ subunit (De Brabander, 1982). Consequently, microtubules, as an oriented elongated structure of dipoles system, have the piezoelectric properties (Athestaedt, 1974; Mascarenhas, 1974).

Microtubules sometimes can be as long as axons of nerve cells, i.e. tenth of centimeters long. Microtubules (MT) in axons are usually parallel and are arranged in bundles. Microtubules associated proteins (MAP) form a "bridges", linking MT and are responsible for their interaction and cooperative system formation. Brain contains a big amount of microtubules. Their most probable length is about $10^{5}$Å.
The viscosity of ordered water in microtubules seems to be too high for transport of ions or metabolites at normal conditions. All 24 types of quasiparticles, introduced in our hierarchic theory of matter (Table 1), also can be pertinent for ordered water in the microtubules (MT). However, the dynamic equilibrium between populations of different quasiparticles of water in MT must be shifted towards primary librational effectons, comparing to bulk water due to clusterphilic interactions. The dimensions of internal primary librational effectons have to be bigger than in bulk water as a consequence of stabilization effect of MT walls on the thermal mobility of water molecules, increasing their most probable de Broglie wave length.

Strong interrelation must exist between properties of internal water in MT and structure and dynamics of their walls, depending on $[\alpha - \beta]$ tubulins interaction. Especially important can be a quantum transitions like convertons $[tr \ll lb]$ and a big fluctuations of internal water, like superdeformons, localized in the volume of primary IR.
The coherent excitation of superdeformons in cytoplasm of neurons ensemble in a course of their firing may be interrelated with disassembly of actin and partially MTs, leading to [gel → sol] transition.

Each of $\alpha\beta$ dimers, composing MT, is a dipole with negative charges, shifted towards $\alpha$ subunit (De Brabander, 1982). Consequently, microtubules, as an oriented elongated structure of dipoles system, have the piezoelectric properties (Athestaedt, 1974; Mascarennas, 1974). Intra-microtubular clusterphilic interactions stimulate the growth of tubules from $\alpha\beta$ tubulin dimers. The structural physical-chemical asymmetry of $\alpha\beta$ dimers in composition of microtubules determines their different rates of growth from the opposite ends ([+] and [-]).

The equilibrium of "closed" (A) and "open" (B) states of nonpolar cavities between $\alpha$ and $\beta$ tubulins in $(\alpha\beta)$ dimers can be shifted to the (B) one under the change of external electric field in a course of membrane depolarization. It can be a consequence of piezoelectric properties of MTs and will stimulate the formation of coherent water clusters in the open nonpolar cavities of $(\alpha\beta)$ dimers. The open cavities can serve as a centers of water cluster formation and molecular Bose condensation (primary librational effectons).

The coherent properties of water and total mass of water in form of Bose condensation in
the hollow core of MTs system should be enhanced as a result of this stage of elementary act of consciousness.

The water in the microtubules, is orchestrated in the volumes of primary electromagnetic deformons (tr or lb). Water can exist alternatively in the form of translational or in the form of librational effectons. Conversion from one type of collective excitation (tr) to another one (lb) can occur simultaneously in many parallel microtubules with similar coherent properties of intra-MT water. It is a result of resonance-exchange process, mediated by electromagnetic, acoustic and vibro-gravitational deformons.

The parallel orientation of MT in different cells, optimal for maximum [MT-MT] resonance interaction could be achieved due to twisting of centrioles, changing spatial orientation of MT. However, it looks that the normal orientation of MT as respect to each other corresponds to the most stable condition, i.e. minimum of potential energy of interaction (Albreht-Buehner, 1990). It is important to stress here that the orientation of two centrioles as a source of MT bundles in each cell are always normal to each other. The stronger is the nerve excitation, the bigger is population of coherently firing cells, tending to similar orientation of their internal MT. We suppose that the critical number of reorganized synaptic contacts is necessary for conversion of short-term memory to the long-term one. It depends on number of excited neurons and degree of MTs system reorganization in each neuron.

The linear dimensions of the edge \( l_{ef} \) of coherent water clusters - primary librational effectons in pure water at physiological temperature 36°C -is about 11Å and 45Å in the ice at 0°C. We assume that in the rigid internal core of MT, the linear dimension (edge length) of librational effecton, approximated by cube, is between 11Å and 45 Å i.e. about \( l_{ef} \approx 23Å \).

It will be shown below, that this assumption fits the spatial and symmetry properties of MT very well. The most probable group velocity of water molecules in composition of primary lb effectons is:
The librational mobility of internal water molecules in MT, which determines \( v_{gr}^{lb} \), should be about 2 times less than in bulk water at 37°C, if we assume \( l_{ef}^{lb} \approx 23\text{Å} \).

The length of a orchestrated group of primary lb effectons in the direction of microtubule main axis can be determined by the length of edge of primary librational IR deformons, i.e. about 10 microns.

Results of our computer simulations for pure bulk water shows, that the distance between centers of primary [lb] effectons, approximated by cube exceed their linear dimension to about 3.5 times (Fig 2b). For our case it means that the average distance between the effectons centers is about:

\[
d = l_{ef}^{lb} \cdot 3.5 = 23 \cdot 3.5 \approx 80\text{Å}
\]

It gives a possibility for equidistant (80 Å) localization of the primary lb effectons in clefts between \( \alpha \) and \( \beta \) tubulins of each \( (\alpha\beta) \) dimer in the internal core of MT. Such a regular spatial symmetry of the internal flickering clusters distribution in MT is an important factor for realization of the [opto-acoustic-conformational] signal propagation of configurational waves along the MT, accompanied by their bending. It is related to alternating [closing \( \Rightarrow \) opening] clefts between \( \alpha \) and \( \beta \) tubulins. This large-scale protein dynamics is correlated with dissociation/association of water clusters in clefts between \( (\alpha\beta) \) dimers of MT due to \([lb/tr]\) convertons excitation with frequency \( 10^7 \text{s}^{-1} \).

The size of tr primary effectons in MT is significantly smaller, than that of lb ones and the microviscosity of water in regions, occupied by translational effectons - lower. The average angle between \( \alpha \) and \( \beta \) tubulins change and the cavity's [open \( \Leftrightarrow \) closed] states equilibrium shifts to the closed one as a result of conversion of lb effectons to tr ones (dissociation of coherent water cluster).
The dynamic equilibrium between tr and lb types of the intra MT water effectons can be very sensitive to $\alpha - \beta$ tubulins interactions, dependent on nerve excitation.

**III. THE SYSTEM OF 3D STANDING WAVES, PRODUCED BY MICRO TUBULES**

Two statements of our Hierarchic model of consciousness are important:

1. The ability of intra-MT primary water librational effectons for superradiation of coherent IR photons from each of the effectons side, approximated by parallelepiped: two identical "longitudinal" IR photons, penetrating along the core of microtubule, forming the longitudinal standing waves inside it and two pairs of identical "transverse" IR photons. Both kinds of waves are responsible for the distant, nonlocal interaction between
microtubules. In accordance to superradiation mechanism (Dicke, 1954), the intensity of longitudinal radiation of MTs is much bigger than that of transverse one;

2. The parameters of the intra MT water radiation (frequency, coherency/amplitude, intensity) is regulated by the interaction of internal water with MT walls, dependent on the [open ⇔ closed] equilibrium of cavity between α and β tubulins, changing in the process of neuron depolarization.

We have to stress here that our idea of IR superradiation, produced by water in MT's or in other condensed matter - is an inherent property of our primary effectons, resulted from mesoscopic molecular Bose condensation (Kaivarainen 1992, 1995). This idea is independent on similar, used in the model of MT's as wave guide of superradiation for longitudinal photons, proposed by M. Jibu et al., (1994). The difference in two approaches is that we assume in MT the existence of "transverse" radiation of IR photons as well as "longitudinal" ones. Such assumption means that the density of electromagnetic energy in MTs is low enough and not destroying the protein's of MT's. Another advantage of our model - is the possibility of electromagnetic interaction between MT's by the exchange of coherent transverse IR photons. We also do not need to use in our model the strong assumption of self-induced transparency in hollow core of MT, because the half of wave length of IR librational photons (about 5µ is much more than the distance between neighboring primary lib. effectons, radiating them.

In the normal animal cells, microtubules grow from the cell center to the cell periphery from the pair of centrioles. In the center of plant cells the centrioles are absent, only some high electron density region is registered. Two centrioles in cells of animals are always oriented at the right angle with respect to each other. Centrioles represent a construction of 9 triplets of microtubules, i.e. two centriole are a source of: (2·27 = 54) microtubules (Fig 3).
Fig 3. a. The scheme of centriole construction from nine triplets of microtubules. The length and diameter of cylinder are 3000 Å and 1000 Å, correspondingly. Each of triplets contain one complete microtubule and two noncomplete MT; b. The scheme of cross-section of cilia with number of MT doublets and MT-associated proteins (MAP): \([2 \cdot 9 + 2] = 20\). One of MT of periphery doublets is complete and another is noncomplete (subfibrilles A and B).

The centriole length is about 3000 Å and its diameter is 1000 Å = 0.01µ. These dimensions mean that all 27 microtubules of each centrioles can be orchestrated in the volume \(v_d\) of one translational or librational electromagnetic deformon:

\[
[v_d = \frac{9}{4\pi} \lambda^3_{p,1,2,3}]
\]

where: \((\lambda_p)_{1,2,3} \sim 10\mu = 10^4\,\text{Å}\) and \((\lambda_p)_{1,2,3} \sim 35\mu = 3.5 \cdot 10^5\,\text{Å}\)

Two centrioles with normal orientation as respect to each other and a lot of microtubules, growing from them, contain the internal orchestrated system of librational water effectons. It represent a quantum system with correalted \((a = b)_{1,2,3}\) transitions of the effectons.

The resonance superradiation or absorption of a number of librational photons \(q\) in the
process of above transitions, is dependent on the number of primary lb effectons ($q$) in the internal hollow core of a microtubule:

$$q \sim [L^\star]L_\parallel$$

where: $[L^\star]$ is the length of microtubule; $L_\parallel^{lb} \approx 3.5 \cdot l_{\text{ef}}^{lb} \approx 80$ Å is the approximate space between internal water primary librational effectons (see Fig.1) and $l_{\text{ef}}^{lb} \approx 23$ Å is the edge length of the primary lb effecton in MT at $360^\circ$C; the value of $q$ in (3.3) determines the intensity (amplitude) of coherent longitudinal librational IR photons radiation from microtubule with length $L^\star$, for the case, when condition of standing IR waves is violated. The frequency of this radiation is defined by eq.(3.5).

It is important that the probabilities of pair of longitudinal and two pairs of transversal photons, emission as a result of superradiance by primary librational effectons are equal, being the consequence of the same collective ($b \rightarrow a$)$_{lb}$ transition. These probabilities can be “tuned” by the electric component of electromagnetic signals, accompanied axon polarization and nerve cell excitation due to piezoelectric properties of MT.

Coherent longitudinal emission of IR photons from the ends of each pair of microtubules of two perpendicular centrioles of the same cell and from ends of one microtubule of other cell can form a 3D superposition of standing photons (primary deformons) as a result of 3 photons pairs interception.

The system of such longitudinal electromagnetic deformons, as well as those formed by transversal photons, have a properties of pilotless 3D hologram. Such an electromagnetic hologram can be responsible for the following physicochemical phenomena, related to morphogenetic field.

- Non-monotonic distribution of intra-cell water viscosity and diffusion velocities in cytoplasm due to corresponding non-monotonic spatial distribution of macrodeformons (Kaivarainen 1995),
- Regulation of spatial distribution of water activity \((a_{H_2O})\) in cytoplasm as a result of corresponding distribution of inorganic ions (especially bivalent such as \(Ca^{2+}\) in the field of standing electromagnetic waves. Concentration of ions in the nodes of standing waves should be higher than that between them. Water activity \((a_{H_2O})\) should vary in the opposite manner than ions concentration. The spatial variation of \((a_{H_2O})\) means the equilibrium of [assembly \(\leftrightarrow\) disassembly] modulation and regulation the length of actin and MTs filaments. As a consequence, the volume and shape of cell compartments will be modulated. The activity of numerous oligomeric allosteric enzymes may be regulated also by variation of \(a_{H_2O}\).

The system of coherent electromagnetic 3D standing waves (primary deformons) is interrelated with that of acoustic and gravitational 3D waves. Microtubules may regulate very different processes in cells and in cells ensembles in space and time. The 3D holograms, creating by MTs, may represent the internal and external "morphogenic fields" and be responsible for differentiation of cells.

The following properties of microtubules can affect the properties of morphogenetic field:

a) total number of microtubules in the cell;
b) spatial distribution of microtubules in the volume of cytoplasm;
c) distribution of microtubules by their length.

d) the constant of \((a \leftrightarrow b)\) equilibrium of primary librational effectons:

\[
K_{a \leftrightarrow b}^{lb} = \exp[-(E_a - E_b)/kT]^{lb}
\]

dependent on the structure and dynamics of \(a\beta\) tubulin pairs forming MT walls. This equilibrium is interrelated, in turn, with \(lb\) photons frequency \((v_{lb})^{1,2,3}\):

\[
[v_{lb} = c(v)_{lb} = (E_b - E_a)_{lb}/h]^{1,2,3}
\]
which is determined by the difference of potential \((V_{a,b})\) and total \((E_{a,b})\) energies between (b) and (a) states of primary effectons in the hollow core of microtubules:

\[
[V_b - V_a = E_b - E_a]_{1,2,3}^{1,2,3}
\]

\((\tilde{v})_{1,2,3}\) is the librational band wave number.

IV. ROLE OF ACTIN FILAMENTS AND MICROTUBULES IN NEURON’S BODY VOLUME/SHAPE ADAPTATION TO NERVE EXCITATION

In the normal state of nerve cell the dynamic equilibrium the gradient of ionic concentration, produced by ionic pumps activity, is compensated by the electric tension gradient. The electrochemical gradient is equal to zero at this state. The equilibrium concentration of \(Na^+\) and \(Cl^-\) in space out of cell is bigger than in cell, the gradient of \(K^+\) concentration has an opposite sign. The external concentration of \(Ca^{2+}\) (about \(10^{-3}\) M) is few orders higher than in cytosol (about \(10^{-7}\) M, such a big gradient provides fast and strong increasing of \(Ca^{2+}\) internal concentration after activation of corresponding membrane channels.

At the “rest” condition of equilibrium the resulting concentration of internal anions of neurons is bigger than that of external ones, providing the difference of potentials equal to 50-100 mV. As far the thickness of membrane is only about 5 nm or 50 Å it means that the gradient of electric tension is about: 100,000 V/sm. i.e. it is extremely high.

Depolarization of membrane usually is related to penetration of \(Na^+\) ions into the cell. This process of depolarization could be inhibited by selected diffusion of \(Cl^-\) into the cell. Such diffusion can produce even hyperpolarization of membrane.

As far the \(\alpha\beta\) pairs of tubulins have the properties of “electrets” (Debrabander, 1982), the piezoelectric properties of core of microtubules can be predicted (Athenstaedt, 1974; Mascarenhas, 1974). It means that structure and dynamics of microtubules can be regulated by electromagnetic field change, which accompanied the nerve excitation.
In turn, dynamics of tubulins of MT's hollow core affects the properties of internal ordered water. Shift of the \([\text{open} \Leftrightarrow \text{closed}]\) states equilibrium of cavity between \(\alpha\) and \(\beta\) tubulins to the open one in a course of nerve excitation should lead to:

1. Increasing the dimensions and life-time of coherent water clusters (primary lb effectons) in the open nonpolar cavities between \(\alpha\) and \(\beta\) tubulins, accompanied by increasing mass of water fraction in MTs in state of Bose condensation (primary librational effectons) and its ratio to fraction of independent molecules (translational effectons) - see Fig. 4;

2. Destabilization of MT, increasing the probability of its partial disassembly and disconnection with plasmatic membrane;

3. The rightward shift of \((A^* \Leftrightarrow B^*)\) equilibrium could be stimulated by librational IR-photons as a result of increasing of superradiance effect and IR photons pumping. This shift increases the probability of cavitational fluctuation of the water in cytoplasm and stimulated reversible disassembly of actin. Concomitant \([\text{gel} \rightarrow \text{sol}]\) transition in cytoplasm is accompanied by cytoplasm viscosity decreasing;

4. Stimulation of the distant interaction between MT of different neurons by the exchange of coherent IR photons and their reorientation-tuning. The increasing of such exchange interaction is a result of increased frequency and amplitude/coherency of IR librational photons.

Twisting of the centrioles of distant interacting cells, bending and reorientation of MTs can occur after \([\text{gel} \rightarrow \text{sol}]\) transition and decreasing of cytoplasm viscosity. This 'tuning' of MT system in excited cells is a result of its tending to configuration, corresponding to minimum of potential energy of interaction between them. Reorganization of actin filaments and MTs system should be accompanied by corresponding changes of neuron's body and its dendrites shape, leading to change of activity of certain ionic channels and synaptic contacts redistribution. This stage is responsible for memory emergency.
The stability of MTs in the nerve cell body is lower than that in bundles of axon or cilia. It is a consequence of fact that microtubules in bundles are interconnected by "handle"-like proteins (deneins) and other microtubule associated proteins (MAP).

At the [sol]-state Ca\(^{2+}\)-dependent K\(^+\) channels turns to the open state and internal concentration of potassium decreases. The latter oppose the depolarization and decrease the response of neuron to external stimuli. The decay of neuron's response is termed "adaptation". This response adaptation is accompanied by MTs-adaptation, i.e. their reorientation, reassembly of actin filaments in conditions, when concentration of Ca\(^{2+}\) tends to minimum. Corresponding backward [sol→gel] transition stabilize the new equilibrium state of excited group of cells. The described hierarchic sequence of stages: from molecular...
Bose condensation of water of MT to synaptic reorganization is responsible for elementary act of consciousness.

The LS-dynamics of tubulin dimers represent the change of "bending" angle between $\alpha$ and $\beta$ tubulins of about $21^0$ (Melki et al., 1989), corresponding to fluctuation of the inter-tubulins cavity between closed (A) and open (B) states. Such bending may be a result of macroconvertors (flickering clusters) excitations with frequency: $(10^5-10^7)\text{Hz}$.

The [assembly$\leftarrow$disassembly] dynamic equilibrium of the actin filaments in cells in terms of colloid chemistry represents [coagulation$\leftarrow$peptization] or [gel$\leftarrow$sol] equilibrium. These cycles are rapid and correlate with neurotransmitter release and nerve excitation (Miyamoto, 1995; Muallem et. al., 1995). The increasing of cell's volume, accompanied the actin orchestrated disassembly is a result of cell "swelling" due to osmotic diffusion of water from the extracellular medium. The decreasing of water activity in cell, inducing osmotic flow of water to cell cytoplasm, is a consequence of increasing of "bound" or "hydration" water fraction after actin microfilaments disassembly to huge number of subunits.

The nerve cell body and dendrites swelling can trigger the collective nonspecific opening of big number of ionic channels and strong resulting postsynaptic potential (PSP) emergency. The bigger is resulting PSP the higher is frequency of the nerve impulses, generated by this cell and penetrating via axon to other neurons (Coombs, et al., 1957).

The new assembly of MT-system in nerve cell's body - stimulates, in accordance to our model, the reorganization of synaptic contacts on the cell surface. It is accompanied by pumping out the extra water from cell and restoring the rest - properties of ionic channels.

The [gel-sol] transition, induced by cavitation fluctuations of water in cytoplasm (superdeformons) can be accompanied by coherent "biophotons" emission/absorption in the ultraviolet (UV) and visible range. Such radiation is possible due to water molecules dissociation$\leftarrow$recombination in a course of cavitation fluctuations. These high-frequency coherent photons exchange, like the IR photons and nerve impulses, propagating via axons - may be responsible for synchronized firing of distant neuron ensembles in head brain.
The firing is a complex nonlinear process. Its characteristic time of about 1/50 of second (20ms) is much longer than pure quantum phenomena in MT like photons radiation and Bose [condensation = evaporation], corresponding in our model to [lb/tr] convertons excitation of the internal water in MTs.

One of the important ideas of HMC is that interactions of distant neurons in head brain can be realized not only by means of nerve impulse via axons. It happens by combination of simultaneous cells bodies classical depolarization with quantum-structural stage: resonant photons exchange between their MTs, leading to their reorientation.

4.1 The entropy-driven information processing

It leads from our HMC that changes of system of electromagnetic, acoustic and vibro-gravitational 3D standing waves in the ensemble of nerve cells, produced by the internal water of MTs in course of braining - may change the properties of this water in a course of MT system reorientation and 'tuning'.

This process induces redistribution of probabilities of different water excitations in huge number of microtubules. It means corresponding change of informational entropy $<I>$, related to microtubules in accordance with known relations (Kaivarainen 1995):

$$<I> = \sum_i P_i \log(1/P_i) = -\sum_i P_i \log(P_i)$$

where: $P_i$ is a probability of the ($i$) state (excitation) with energy ($E_i$), defined as:

$$P_i = \frac{\exp(-E_i/kT)}{\sum_i \exp(-E_i/kT)}$$

For the total system the well known relation between entropy (S) and information (I) is:

$$S(e.u.) = k \cdot \ln W = (k \cdot \ln 2)I = 2.3 \cdot 10^{-24} I(bit)$$

where: statistical weight of macrosystem:
the total number of internal water molecules in macrosystem of interacting MT is:

\[ N = N_1 + N_2 + \ldots + N_i \]

\[ [i] \] is number of non degenerated states of 24 quasiparticles of intra MT water.

The information amplitude of condensed matter, we introduce as a product of the number of molecules (\( N_i \)) in each of \([i]\) collective excitations:

\[ N_m^i = V_i/N_{H_2O} = (1/n_i)/(V_0/N_0) \]

on informational entropy (4.1):

\[ <IA> = <I>N_m^i = [-N_0/V_0] \cdot \sum_i P_i \log_2(P_i)/n_i \]

where \( N_0 \) and \( V_0 \) are the Avogadro number and molar volume of water; \( V_i = 1/n_i \)

is a volume of excitation of \((i)\)-type; \( n_i \) is concentration of corresponding excitations.

The distant energy exchange between MT, accompanied by the change of \( P_i \) for different excitations can be considered as an informational exchange between nerve cells. It is related to change of fractions of water excitations in system of interacting MTs.

4.2. Factors, affecting the equilibrium constant of two-state excitations of water in MT

A. The dimensions of water librational effectons in given microtubule and their life-time, which increases with probability of open states of nonpolar cleft between \( \alpha \) and \( \beta \) tubulins;

B. The equilibrium constants between “acoustic” (a) and “optic” (b) states of primary effectons \((K_{a\leftrightarrow b})_{tr,lb}\), between \( tr \) and \( lb \) primary effectons \((K_{tr\leftrightarrow lb})\), secondary effectons \((K_{\pi\leftrightarrow \pi})_{tr,lb}\) and that of supereffectons \((K_A \leftrightarrow B)\) are presented below:
(K_{a\leftrightarrow b})_{tr,lb} = \exp[-h(v_a - v_b)/kT]_{tr,lb} = \exp[-h\nu_p/kT]_{tr,lb}

K_{tr\leftrightarrow lb} = (K_{a\leftrightarrow b})_tr \cdot (K_{a\leftrightarrow b})_lb = \exp[-h(v'_p + v''_p)/kT]_{lb}

(K_{\pi\leftrightarrow \overline{\pi}})_{tr,lb} = \exp[-h(v_{\pi} - v_{\overline{\pi}})/kT]_{tr,lb} = \exp[-h\nu_{ph}/kT]_{tr,lb}

K_{A* \leftrightarrow B*} = \exp[-h(v_A* - v_B*)/kT] =

(K_{A\leftrightarrow B})_{tr} \cdot (K_{A\leftrightarrow B})_{lb} = [K_{a\leftrightarrow b} \cdot K_{\pi\leftrightarrow \overline{\pi}}]_{tr} \cdot [K_{a\leftrightarrow b} \cdot K_{\pi\leftrightarrow \overline{\pi}}]_{lb}

The primary effectons equilibrium constants \((K_{a\leftrightarrow b})_{tr,lb}\) are related to difference between the total and potential energies of \((b)\) and \((a)\) states and resulting frequency of coherent IR radiation \((\nu_p)_{tr,lb}\) of water primary tr and lib effectons (eq. 3.4).

We have at least five defined parameters of water in MT, involved in the quantum processes of nerve activity in our model. Intensity of IR superradiance and vibro-gravitational waves, radiated by MT system;

1. Frequency of coherent IR radiation, produced by water of the microtubule system, responsible for distant cooperation between microtubules;

2. The life-time of primary lb effecton \((\tau_{lb})\) and probability of \([lb \leftrightarrow tr]\) conversion equilibrium of water in MT, interrelated directly with \([B \leftrightarrow A]\) equilibrium of nonpolar cavities between \(\alpha\) and \(\beta\) tubulins;

3. Frequency \((\nu_{A* \leftrightarrow B*})\) of a big cavitational fluctuations (superdeformons), responsible for MT reversible disassembly (catastrophe), collective bending and reorganization of microtubule system, leading to a new [volume / shape] state of the nerve cell body;

4. Frequency and intensity of high-frequency "biophotons", resulted from recombination of water molecules after their dissociation in a course of intra-MT water cavitational fluctuation (superdeformons).
Thus, braining and consciousness in accordance with HMC is a process of synaptic contacts redistribution as a result of direct axons-mediated interaction and distant quantum exchange between MT of different cells by means of coherent IR photons, and vibro-gravitational waves (VGW).

This exchange can be accompanied by the oscillations of constants of \([tr \leftrightarrow lb], \(a \leftrightarrow b\)\) and \((A^* \leftrightarrow B^*)\) equilibrium, as a result of periodic redistribution of energy between subsystems of the effectons and deformons (Kaivarainen 1995). In the case of braining, however such autooscillations could be stimulated by periodic excitation, which accompanied nerve impulse propagation along the axon.

Autowaves originate as a result of interaction of given cell microtubules with the microtubules of the surrounding cells, mediated mainly by electromagnetic (IR) primary deformons. In this case, autowaves represent spatially distributed oscillations of \([a \in b]\) and \([A^* \leftrightarrow B^*]\) equilibrium constant in the active medium of nerve cells ensembles, accompanied by their reorganization. The active medium is defined as an two-level system which can relax to the former energy distribution after excitation.

As a result of competition, one of the sources of the autowaves with highest frequency in form of rotating curl (reverberator) rises up and becomes the leading and dominating one. It is known that autowaves with highest frequency suppress other sources of autowaves in the active medium. Reverberators originate as a result of the autowave breach at non-homogeneities of the active medium and they are able to multiplication.

Dissipative structures, introduced by Prigogin, can be considered as a private case of the autowaves and termed "freezing out" autowaves (Andronov et al., 1981). Autowaves in the neuron chains are related to oscillation of

\([A^* \leftrightarrow B^*]\) and \([gel \leftrightarrow sol]\) equilibrium

in a big groups of nerve cells. They include also two related phenomena on mesoscopic and macroscopic scale: polarization/depolarization of neuron's membranes; collective activation/relaxation of synaptic connections, etc.
Competition between autowaves in neuron ensembles is the crucial phenomena in "selection of final result", as an elementary act of consciousness in the process of recalling and braining in accordance with our model. The subsystems of primary electromagnetic, acoustic and gravitational deformons with properties of pilotless hologram, produced by microtubules, are responsible for distant phenomena, necessary for autowave emergency.

Frequency and amplitude of supereffectons equilibrium constant \( K_{A^* \rightarrow B^*} \) oscillations can serve as an additional informational parameter, related to autowaves excitation in brain.

Our model consider fluctuations and dissipation, stimulating gel\textasciitilde{}sol transitions and synaptic system reorganization, as a necessary phenomena for brain "working". However this CHAOS is organized by quantum phenomena, like Bose-condensation of water in composition of primary lb effectons in MT, their superradiance and self-induced bistability. The higher is quantum order and coherence, the less is the number of mistakes in brain working. At the same time, the possibility of mistakes due to competition between discreet quantum and continuous thermal properties, producing thermal fluctuations, Brownian movement and decoherence-make the process of braining NON-DETERMINISTIC. The main difference between computer and brain looks be in the fact that in the brain, in contrast to computer, the input and output the information is not always adequate to each other.

The IN T U I T I O N from such point of view means the ability to choose one right solution (rigorously inadequate) from huge number of wrong, but adequate or almost adequate to the available information. It looks that associative memory, helping the right choose, is the most probable background for INTUITION.

V. CONCLUSIONS OF HIERARCHIC MODEL OF CONSCIOUSNESS
We can resume now, that in accordance with our HMC, the sequence of following interrelated stages is necessary for elementary act of perception and memory (see Fig.5). The mechanism proposed needs the existence the following stages of each elementary act
of perception and memory, resulted from simultaneous excitation and depolarization of big
enough number of neurons, forming cooperative ensemble:
1. The change of the electric component of neuron's body internal electromagnetic field as a
result of cells depolarization;
2. Opening the potential - dependent Ca$^{2+}$ channels and increasing the concentration of
these ions in cytoplasm. Activation of Ca$^{2+}$-dependent protein gelsolin, which stimulate fast
disassembly of actin filaments;
3. Shift of $A \rightleftharpoons B$ equilibrium between the closed (A) and open to water (B) states of
cleft, formed by $\alpha$ and $\beta$ tubulins in tubulin pairs of microtubules (MT) to the right as
a consequence of piezoelectric effect, induced by depolarization of membrane of nerve cell;
4. Increasing the life-time and dimensions of coherent "flickering" water clusters in MT,
representing the 3D superposition of de Broglie standing waves of $H_2O$ molecules in
hollow core of MT. It is a result of the water molecules immobilization by 'open' nonpolar
clefts of $(\alpha\beta)$ dimers in MT;
5. Increasing the superradiance of coherent IR photons induced by synchronization of
quantum transitions of the effectons between acoustic and optic like states. Corresponding
increasing of probability of superdeformons (cavitational fluctuations) excitation in water of
cytoplasm;
6. The disassembly of actin filaments system to huge number of subunits, [gel $\rightarrow$ sol]
transition and increasing of water fraction in hydration shell of proteins in cytoplasm. This
transition is a result of cavitational fluctuations and destabilization of actin filaments by Ca$^{2+}$.
Corresponding decreasing the water activity in cytoplasm - increases strongly the passive
osmotic diffusion of water from the external volume to the cell;
7. As a consequence of previous stage, a jump-way increasing of the nerve cell body volume
(pulsation), accompanied by disrupting the (+) ends of MTs with cytoplasmic membranes
occur. This stage makes it possible for MTs to change their orientation inside neuron's
body;
8. Spatial "tuning" - collective reorientation of MTs of simultaneously excited neurons to geometry, corresponding to minimum potential energy of distant (but not nonlocal) electromagnetic and vibro-gravitational interaction between MTs and centrioles twisting.

9. Decreasing the concentration of Ca$^{2+}$ to the critical one, when disassembly of actin filaments is stopped and [gel ⇄ sol] equilibrium shifts to the left again, stabilizing the new MTs system spatial configuration and corresponding nerve cell body volume and geometry. This new geometry of nerve cells after fixation of (+) ends of MTs back to plasmatic membrane - determine the new distribution of ionic channels activity and reorganization of synaptic contacts in all excited ensemble of neurons after relaxation, i.e. short-term and long-term memory.

This cyclic consequence (hierarchy) of quantum mechanical, physicochemical and classical nonlinear events can be considered as elementary acts of memorizing and consciousness. The total period of listed above stages can be as long as 500 ms, i.e. half of second.

The elementary act of consciousness described, includes a stage of coherent electric firing in brain (Singer, 1993) of distant neurons groups with period of about 1/140sec. Corresponding frequency may be related to frequency of superdeformons (cavitational fluctuations) origination in of cytoplasm, stimulating [gel-sol] transition of cytoplasm, following after depolarization of nerve membranes. This frequency for pure water, calculated on the base of Hierarchic theory (Kaivarainen, 1995; 2000), is about $10^9s^{-1}$. However, in viscous medium of cytoplasm it may be much lower $10^7s^{-1}$.

The process of cavitational fluctuations 'collapsing' is accompanied by high-frequency (UV and visible) "biophotons" radiation due to recombination of part of water molecules. These biophotons may be responsible for short range morphogenetic field in contrast to coherent IR photons, responsible for long-range morphogenetic field.

The dimension of IR superdeformon (3D superposition of IR photon) edge is determined by the length of librational IR standing photon - about 10 microns. It is important that this dimension corresponds to the average microtubule length in cells confirming in such a way
our idea. Another evidence in proof is that the resonance wave number of excitation of superdeformons, leading from our model is equal to 1200(1/cm).

The experiments of Albrecht-Buehler (1991) revealed that just around this frequency the response of surface extensions of 3T3 cells to weak IR irradiation is maximum. Our model predicts that IR irradiation of microtubules system in vitro with this frequency will dramatically increase the probability of microtubules catastrophes. It's one of the way to verify our model experimentally.

Except superradiance, two other cooperative optic effects could be involved in supercatastrophe realization: self-induced bistability and the pike regime of IR photons radiation (Bates, 1978; Andreev et al.,1988). Self-induced bistability is light-induced phase transition. It could be related to nonlinear shift of \([a \leftrightarrow b]\) equilibrium of primary librational effectons of intra MT water to the right as a result of saturation of IR (lb)-photons absorption. As far the molecular polarizability and dipole moments in (a) and (b) states of the primary effectons-differs, such shifts of \([a \leftrightarrow b]\) equilibrium should be accompanied by periodic jumps of dielectric permeability and stability of coherent water clusters. These shifts could be responsible for the pike regime of librational IR photons absorption and radiation.

As far the stability of b-states of lb effectons is less than that of a-states, the characteristic frequency of pike regime can be correlated with frequency of MTs-supercatastrophe activation. This effect can orchestrate the [gel-sol] transitions of neuronal groups in head brain.
Fig 5. The schematic presentation of the local, acousto-conformational and distant-electromagnetic interactions between microtubules (MT1 and MT2), connected by MAP.

MAP-microtubules associated proteins stabilize the overall structure of MTs. They prevent the disassembly of MTs in bundles of axons and cilia in a course of their coherent bending. In neuron's body the concentration of MAP and their role in stabilization of MTs is much lower than in cilia.

The local acousto-conformational signals between MT are realized via MTs-associated proteins (MAP), induced by transitions of the cleft, formed by α and β tubulins, between closed (A) and open (B) states. The orchestrated dynamics of individual
MT as quantum conductor is a result of phonons \((h
u_{ph})\) exchange between \((\alpha \beta)\) clefts due to \([lb/\ellr]\) conversions, corresponding to water clusters, "flickering", in-phase to \([B \leftrightarrow A]\) pulsations of clefts.

The distant electromagnetic and vibro-gravitational interactions between different MT are the consequence of IR photons and coherent gravitational waves exchange. The corresponding two types of waves are excited as a result of orchestrated \((a \leftrightarrow b)\) transitions of water primary librational effectons, localized in the open B- states of \((\alpha \beta)\) clefts.

When the neighboring \((\alpha \beta)\) clefts has the alternative open and closed states like on Fig 2, the general spatial structure remains straight. However, when \([A \leftrightarrow B]\) equilibrium of all the clefts from one side of MT are shifted to the left and that from the opposite side are shifted to the right, it leads to bending of MT. Coherent bending of MTs could be responsible for [volume/shape] vibrations of the nerve cells and the cilia bending.

The Brownian effects, which influence reorientation of MTs system and probability of cavitation fluctuations, stimulating [gel-sol] transition in a course of nerve cells tuning and excitation-relaxation cycles - represent in our model the non-computational element of consciousness. Other models (Wigner, 1955; Penrose, 1994) relate this element to wave function collapsing.

**The idea of new device: Audio/Video Signals Skin Transmitter**

In this device the laser beam with resonant frequency and ultraweak intensity should be modulated by acoustic and/or video signals. Then, the modulated output optic signals will be transmitted to the nerve nodes of skin or to chakras, using wave-guides. The nerve impulses, stimulated by modulated laser beam, can propagate via complex axon-synapse system to brain centers, responsible for perception and processing of audio and video information. The long-term memorizing process also can be stimulated effectively by Skin Transmitter.
The telepathic abilities of people could be enhanced strongly due to increasing the coherency of quantum neurodynamics of the nerve nodes in chakras and brain. Another principle of neuromodulator can be based on ability of Aharonov-Bohm effect influence the biocells. The applicators, containing solenoids, producing Aharonov-Bohm effect with frequency of acoustic signals or brain's $\alpha$ or $\beta$ rhythms, applied to skull and chakras, can be of help for deaf people and that with nerve system diseases.

The direct and feedback reaction between brain centers, responsible for audio and video information processing and certain nerve nodes on skin is anticipated from our model.

One of the important consequence of our Hierarchic model of consciousness is related to radiation of ultraviolet and visible photons ("biophotons") as a result of water molecules recombination after their dissociation. Dissociation can be stimulated by cavitation fluctuation of water in cytoplasm (superdeformons), modulated by MTs of excited nerve cells. The frequency and intensity of this electromagnetic component of biofield, in turn, can affect the kinetic energy of the electrons, emitted by skin in the process of Kirlian effect measurement. It is predictable that the above mentioned stimulation of psi-activity by resonant external radiation, should influence on colors and character of Kirlian picture even from distant untreated points of skin.

There are another resonant frequencies also, calculated from our theory, enable to stimulate big fluctuations of water in MTs and their disassembly. Verification of these important consequences of our model and elaboration of Audio/Video Signals Skin-Transmitter is the intriguing task of future. The practical realization of Audio/Video Signals Skin Transmitter could be a good additional evidence in proof of HMC and useful for lot of people with disfunction of audio and video perception.

APPENDIX

Possible Mechanism of Wave Function Collapsing

A lot of superimposed possible quantum states of any quantum system are always "collapsed" or "reduced" to single state (or looks to be so) as a result of measurement, i.e. interaction with detector.
In accordance to "Copenhagen interpretation", the collapsing of such system to one of possible states is unpredictable and purely random. Roger Penrose supposed (1989) that such a collapse is due to quantum gravity, because the latter influences the quantum realm acting on space-time. After certain gravity threshold the system's wave function collapsed "under its own weight".

Penrose (1989, 1994) considered the possible role of quantum superposition in synaptic plasticity. He characterized the situation of learning and memory by synaptic plasticity in which neuronal connections are rapidly formed, activated or deactivated: "Thus not just one of the possible alternative arrangements is tried out, but vast numbers, all superposed in complex linear superposition". The collapse of many cytoskeleton configuration to single one is a nonlocal process, required for consciousness.

Herbert (1993) estimated the mass threshold of wave function collapse roughly as $10^6$ daltons. Penrose and Hameroff (1995) calculated this threshold as

$$\Delta M_{col} \sim 10^{19} D$$

Non-computable self-collapse of a quantum coherent wave function within the brain may fulfill the role of non-deterministic free will after Penrose and Hameroff (1995).

Our model, including the increasing of the total mass of water in microtubules, involved in mesoscopic Bose-condensate (primary librational effectons), as a crucial stage of perception elementary act does not contradict the above idea of nonlocal mechanism of collapsing of configurational space of cytoskeleton.

The mass of water in one microtubule with most probable length $\sim 10^5\text{Å}$ and diameter $140\text{Å}$ is about

$$m_{H_2O} \sim 10^8 D$$

In accordance with our calculations for bulk water, the fraction of molecules in composition of primary $\text{tr}$ effectons is about 23% and that in composition of primary $\text{lb}$ effectons is about ten times less (Fig.4). In MTs due to clusterphilic interaction, the $[\text{lb}]$ fraction, representing molecular Bose condensate can be bigger.
We assume, that in MTs at least 10% of the total water mass can be additionally converted to primary librational effectons as a result of neuron depolarization before MT disassembly. This corresponds to increasing of mass of these quasiparticles in one MT as:

$$\Delta m_{H_2O} \approx 10^6 D$$

accompanied by decreasing of water mass, involved in other types of excitations in MT.

Based on known experimental data that each nerve cell contains about 50 MT, we assume that the maximum increasing of mass of primary effectons in one cell could be:

$$\Delta M_{H_2O} \approx 50 \cdot \Delta m_{H_2O} = 5 \cdot 10^7 D$$

If the true value of mass threshold, responsible for wave function collapse, $\Delta M_{\text{col}}$ is known, then the number $(N_{\text{col}})$ of neurons in assemblies, required for this process is

$$N_{\text{col}} \sim (\Delta M_{\text{col}}/\Delta M_{H_2O})$$

The total number of nerve cells in human brain is about $N_{\text{tot}} \approx 10^{11}$. The critical fraction of cells population, participating in elementary act of perception can be calculated as:

$$f_c = (N_{\text{col}}/N_{\text{tot}})$$

In our model the "tuning" of microtubules orientations, dependent on thermal fluctuations, is another explanation of "collapsing" of neurons group, leading to noncomputable "choosing" of one state from huge number of possible. It is accompanied by redistribution of synaptic contacts due to distant (but not nonlocal) electromagnetic and vibro-gravitational resonant interactions between MTs.

Our model agrees with general idea of Marshall (1989) that Bose-condensation could be responsible for "unity of conscious experience". However, our model explains how this idea can work in detail and what kind of Bose condensation is necessary.
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