Hierarchic Model of Consciousness, proposed in this work, is based on Hierarchic Theory of Matter and Field, developed by the author (Kaivarainen, 1995; 1998).

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 unharmonic translations and librations of molecules and providing the possibility of high-temperature molecular Bose condensation;
- electromagnetic (IR) waves;
- acoustic waves;
- vibro-gravitational waves, excited by coherent translational and librational oscillations of molecules, accompanied by alternating accelerations.

Corresponding hierarchic system of 24 excitations, describing virtually all the properties of any condensed matter, can be generated by quantum transitions of the coherent water clusters, localized in cytoplasm and in the microtubules of neurons bodies. Most important primary collective excitations in form of coherent clusters are resulted from high-temperature molecular Bose-condensation of water (see Appendix).

We assume in our model the existence of feedback reaction between the following hierarchy of phenomena, representing interrelation of quantum microscopic, mesoscopic and nonlinear macroscopic events:

a) hologram-like superposition of four types of 3D waves, listed above;

b) correlated MTs orientations, responsible for volume and geometry of cells body in the tuned ensembles of neurons;

c) quantity and distribution of synaptic contacts on the surface of the nerve cells bodies, dependent on geometry of cells.
It is assumed in our model that [gel→sol] transitions in cytoplasm of neuron’s body, produced by collective disassembly of big number of actin filaments and microtubules, as a consequence of nerve excitation and neuron’s body depolarization, - is accompanied by its volume and shape ”pulsation”. The twisting of centrioles in cells to orientation, corresponding to maximum energy of the MTs distant interaction by means 3D electromagnetic and vibro- gravitational waves - is an important stage of the excited neurons dynamic adaptation to each other. Such adaptation becomes possible only in low viscosity - [sol] state of cytoplasm.

As a result of cell’s volume/shape pulsation, induced by reversible osmotic equilibrium change, the distribution of synaptic contacts on the surface of cells and/or ionic channels activity - change. These changes provide the long-term and short-term memory correspondingly. The synaptic redistribution is determined by MTs spatial re-orientations and changes of their length. The processing of huge number of such ”informational acts as MTs - dependent synaptic rearrangements”, accompanied by emergency of new states of neuron ensembles and hologram-like fields, is responsible for consciousness and braining.

The mechanism proposed needs the existence of feedback reaction between following stages of HMC:

a) simultaneous depolarization of big enough number of neurons, forming ensemble, accompanied by opening the potential-dependent channels and increasing the concentration of $\text{Ca}^{2+}$ in cytoplasm of neurons body;

b) collective disassembly of actin filaments and MTs, accompanied by [gel→sol] transition of big group of depolarized neurons due to their destruction by $\text{Ca}^{2+}$ – activated proteins like gelsolin and villin;

c) strong decreasing of cytoplasm viscosity and disjoining of the (+) ends of MTs from membranes, making possible the spatial redistribution of MTs orientations, corresponding to maximum resonance exchange interaction of MTs by means of IR photons and vibro-gravitational waves in simultaneously excited group of neurons;

d) volume/shape pulsation of neuron’s body and dendrites, inducing reorganization of ionic channels activity and synaptic contacts in the excited neuron ensembles. These volume/shape pulsations occur due to reversible decrease of the intracell water activity and corresponding swallow of cell as a result of passive osmotic diffusion of water from the external space.

The probability of actin filaments and MTs disassembly and [gel→sol] transition can be enhanced not only by the $\text{Ca}^{2+}$ concentration increasing, but also by cavitational fluctuations, stimulated by superf ormson and macroconvertons in accordance to our Hierarchic theory of matter. Our model predicts that if the neurons or other cells,
containing actin and MTs, will be treated by modulated acoustic or electromagnetic field with resonance frequency of cytoplasmic water cavitation fluctuations ($\nu_{res} \geq 1 \cdot 10^{4} s^{-1}$), it will activate simultaneous disassembly of big number of actin filaments and MTs, responsible for maintaining the specific cell volume and geometry. As a result, it activates the neuron's body volume/shape pulsation, depending on applied modulation.

Such external stimulation of supercatastrophe or [gel→sol] transitions has two important consequences:

- The first one is generation of strong high-frequency nerve impulse, propagating via axons and exciting huge number of other nerve cells, i.e. distant nerve signal transmission in living organism;
- The second one is stimulation the leaning process as far long-term memory in accordance to HMC, is related to synaptic contacts reorganization, accompanied the neuron volume/shape pulsation.

I. INTRODUCTION

In accordance to our Hierarchic concept (Kaivarainen, 1992, 1995) general for liquids and solids, any condensed matter, including the biosystems, represents cooperative [opto-acoustic-gravitating] system. Summary of this theory is presented in the Appendix.

A usual hologram is a record of the object on the light-sensitive material in the form of interference image, resulting from mixing of the field, radiated by object with a coherent pilot wave.

We assume here that interrelated subsystems of the effectons, transitons, acoustic, electromagnetic deformons and corresponding vibro-gravitational excitations in biosystems, can be considered as superposition of three types of holograms: acoustic, optic and gravitational ones. An acoustic hologram (secondary acoustic deformons), as well as an optical and gravitational ones (formed by 3D electromagnetic and gravitational standing waves), represent the interference image, determined by cell's components and different water fractions properties.

Under certain conditions an acoustic pilot signal can be substituted for an electric one (Prokhorov, 1988). This can occur during the transmission of a nerve impulse along axons and neurons.

The frequency of electromagnetic field related to change of ionic flux in excitable tissues usually does not exceed 1000 Hz (Kneppo and Titomir, 1989).

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.
We put forward a hypothesis here that a "informational state", which reflects a kind of brain excitation, is related to certain hierarhic hologram-like system of coherent electromagnetic, acoustic and vibro-gravitational 3D standing waves. Such a system can be produced by coherent unharmonic oscillations of water molecules in composition of primary effectons and their quantum transitions. In microtubules the degree of Bose condensation, which determined the fraction of primary librational effectons and orchestration of all dynamic process in water should be enhanced due to stabilization of water by walls of MTs.

The coherent large-scale fluctuations of α and β tubulins, stimulated by water macroconverters with frequency of about $10^7$ Hz also could be a source of vibro-gravitational and electromagnetic waves.

Reorganization of actin and microtubule systems after collective disassembly (supercatastrophe), accompanied by [gel—sol] transition, induced by nerve excitation, is interrelated with cells volume and shape changes. The reorientation of centrioles of cells to state, corresponding to most effective resonance exchange between MTs by 3D IR photons and vibro-gravitational waves is one of the stage of the "elementary act of consciousness". Such ”tuning” of MTs becomes possible because of strong declining of cytoplasm viscosity, resulted from [gel-sol] transition.

As a consequence of such reorganization of microfilaments and microtubules system in the nerve cell body and dendrites, the number of the active ionic channels and distribution of active synaptic contacts on the surface of cells - will change. The processing of these "informational acts" in the head brain is responsible for consciousness, short and long-term memory and cognition.

Such a mechanism means the existence of feedback reaction between two stages of consciousness act:

a) quantum exchange process in microtubule (MT) system of simultaneously excited distant nerve cells, leading to spatial reorientation of MTs and their tuning;

b) reorganization of synaptic contacts in corresponding neuron ensembles, depending on the new "tuned" spatial distribution of MTs.

The vibro-gravitational 3D standing waves contain information about all kind of dynamic processes in condensed matter (effectons and deformons), i.e. their informational volume is much more than that of IR- optic and acoustic deformons (see "New articles" in http://www.karelia.ru/~alexk).

In such a way our model agrees with idea of Karl Pribram (Languages of the Brain, CA, 1977) of holographic principles of memory and braining and with its later development (Hameroff, 1987, 1994; Lechleiter et al., 1991; Jibu et all., 1994).
Nowadays to derive an acoustic hologram in the range of ultrasonic frequencies, the nematic liquid crystals have already been used. The long axes of molecules in nematic liquid crystals are parallel to each other, like in biomembranes.

Biological membranes are formed by lipids representing two-chain amphiphilic molecules. They form double layers in the aqueous environment, where the nonpolar tails are turned to each other, and the polar ones - to the aqueous environment (Cantor and Schimmel, 1980).

Brain represents a complex liquid crystal system. The grey substance consists mainly of cerebrosides, phosphatides, and glycerides forming lyotropic liquid crystals.

Myelin shell, which surrounds the conducting nerve fibers - axons, has the properties of high-ordered nematic crystals (Chistyakov, 1966).

Some types of holograms, e.g. echo-holograms, have a properties of not only spatial, but also temporal memory. Three-dimensional holograms have a big informational capacity and an associative character of memory.

The pilotless writing of a hologram is possible, when the radiation of every object’s point can be considered as a pilot one relative to its all other points. In this case, the three-dimensional hologram, can be restored by means of only the part of the object’s points, which is able to ”recollect” it as a whole.

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 the eectons and deformons. Hence, it is immediately related to the dynamic, mechanic and geometrical properties of membranes, cell’s filaments and even [DNA-protein] complexes.

The code way of keeping the information in the form of the eectons and deformons as 3D standing waves (de Broglie waves, electromagnetic, acoustic and vibro-gravitational) in the intra-microtubule coherent water looks very effective and could be used in future quantum computer technology.

It is an important point of our Hierarchic model of consciousness that two subsystems: [microtubules + internal water] and [actin filaments+cytoplasmic water] are strongly interdependent and their interaction can be modulated by postsynaptic potential (PSP) changes, activating Ca$^{2+}$ – channels.

Stability of MT, actin filaments and probability of their disassembly is dependent also on the concentration of Ca$^{2+}$ and water activity changing in a course of membranes depolarization.

Before depolarization the concentration of Ca$^{2+}$ outside of cell is about $10^{-3} M$ and inside about $10^{-7} M$. Such strong gradient provide fast increasing of these ions concentration in cell till $10^{-5} M$, enough to activate protein gelsolin.

It is shown that [gel-sol] dynamic equilibrium (cycles) can be rapid and cor-
relate with release of neurotransmitter vesicles from presynaptic axon terminals (Miyamoto, 1995; Mualem et al., 1995).

Hameroff proposed that in his and Penrose "orchestrated objective reduction [orch. OR]" model (Hameroff and Penrose, 1996a,b; Hameroff, 1996, 1998) quantum computation/superposition phase occurs in MTs during the gel phase of sol-gel cycles of frequency about 40 Hz. He assumed that solid-like gel surrounding the MTs can serve as a shield of thermal noise and provide a condition for MTs dynamics coherency, necessary for OR. It is shown by Wachstock (1994), that gel state, depending on actin cross linkers, can serve as a shock absorber indeed.

In our model, in contrast to that of Hameroff’s, the key phenomena - spatial adaptation of MTs of distant cells due to resonance electromagnetic and vibro-gravitational interaction as an intermediate stage of synaptic reorganization occur in low viscous sol state.

However, our HMC as it will be shown below, does not contradict the idea of Orch. OR model. Instead of coherent redistribution of mass of MT’s proteins, which after Hameroff’ assumption should lead to new space-time geometry, our model propose the coherent change of water mass, involved in high-T molecular Bose condensate inside MTs in form of coherent water clusters - primary librational effectons (see Appendix).

HMC also have some common features with model of Quantum Brain Dynamics (QBD), proposed by L.Riccardi and H.Umezawa in 1967 and developed by C.I.Stuart, Y.Takahashi, H.Umezawa (1978, 1979), M.Jibu and K.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 M.Jibu and K.Yasue,1993). In other paper (1992) these authors gave more concrete definitions:

"Corticons are nothing but quanta of the molecular vibrational field of biomolecules (quanta of electric polarization, confined in protein filaments). Exchange bosons are nothing but quanta of the vibrational field of water molecules...". One can find some analogy between spatially localized "corticons" and our effectons as well as between "exchange bosons" and deformons.

Jibu, Yasue, S.Hagan and others (1994) discussed a possible role of quantum optical coherence in cytoskeleton microtubules: implications for brain function. They considered MTs as wave guides for coherent superradiation - collective nonlinear phenomena. They assumed also that coherent photons, penetrating in MTs, lead to phenomenon called "self-induced transparency".

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 41800. Each G-actin subunit is stabilized by one ion $\text{Ca}^{2+}$ and is in noncovalent complex with one ATP molecule. Polymerization of G-actin is accompanied by splitting of the last phosphate group. The velocity of F-actin polymerization is enhanced strongly by hydrolysis of ATP. However, polymerization itself do not needs 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.

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 [assembly ⇔ disassembly] equilibrium of microtubules composed of $\alpha$ and $\beta$ tubulins is strongly dependent on internal and external water activity $a_{H_2O}$ (see Section 13.7 of book: Kaivarainen 1995; 1997), concentration of $Ca^{2+}$ and on the electric field gradient change due to MTs piezoelectric properties.

The $\alpha$ and $\beta$ tubulins are globular proteins with equal molecular mass ($MM = 55,000$), usually forming $\alpha\beta$ 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 MTs.

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 $d_{in} = 140$Å and external diameter $d_{ext} = 280$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:

$$l_t = (1 - 20) \cdot 10^5 \text{Å}$$  \hspace{1cm} (2.1)
The spacing between the tubulin monomers in MT is about 40 Å and that between αβ dimers: 80 Å are the same in longitudinal and transversal directions of MT.

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 in book: Kaivarainen 1995; 1997), 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 (see section 13.3 of book: Kaivarainen 1995 and ”New articles” in: http://www.karelia.ru/~alexk). 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 $|α - β|$ tubulins interaction. Especially important can be a quantum transitions like convertons $[tr ⇔ lb]$ and a big fluctuations of internal water, like superdeformons, localized in the volume of primary IR librational deformon. The convertons in are accompanied by [dissociation/association] of primary librational effectons, i.e. flickering of coherent water clusters and can induce the change of angle between α and β subunits in tubulin dimers.

The biggest cavitational fluctuations - (superdeformons) can induce total cooperative disassembly of MT. Superdeformons excitation in MT internal water could be an explanation of experimentally revealed dynamic instability (catastrophes) as a stochastic switching of MT growth to shrinkage (Mitchison and Kirschner, 1984; Horio and Hotani, 1986; Odde at al., 1994).
Each αβ dimer is a dipole with negative charges, shifted towards α 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 (see Section 13.5) stimulate the growth of tubules from αβ tubulin dimers. The structural physical-chemical asymmetry of αβ 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 α and β tubulins in (αβ) 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 cavities of (αβ) dimers. The open cavities can serve as a centers of water cluster formation and molecular Bose condensation. The coherent properties of water, in the hollow core of microtubules should be enhanced as a result of such process.

The water in the microtubules, is orchestrated in the volumes of primary electromagnetic deformons (tr or lb). Water can exist al-
ternatively 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 (see 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.

The linear dimensions of the edge ($l_{ef}^{lb}$) of coherent water clusters - primary librational effectons in pure water at physiological temperature (36°C) is about 11 Å and 45 Å 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 $l_{ef}^{lb} \sim 23$Å.

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:

$$v_{gr}^{lb} \sim \frac{\hbar}{m_{H_2O} \cdot l_{ef}^{lb}}$$

(2.2)

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 $l_{ef}^{lb} \sim 23$Å (see article 1.1 in ”New articles” http://www.karelia.ru).

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 (see attachment), 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:

$$d = l_{ef}^{lb} \cdot 3.5 = 23 \cdot 3.5 \sim 80$$

(2.3)
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 (Fig 2) is an important factor for realization of the [opto-acoustic-conformational] signal propagation of configurational waves along the MT, accompanied by their bending is related to alternating [closing$\leftrightarrow$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 (Fig.2) due to $[lb/tr]$ convertons excitation and phonons exchange.

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 must to be very sensitive to $\alpha$ – $\beta$ tubulins interactions, dependent on nerve excitation, in accordance to our model.

**Fig. 2.** Theoretical temperature dependencies of:
(a) - the space between centers of primary $[lb]$ effectons (calculated in accordance to eq.4.62);
(b) - the ratio of space between primary $[lb]$ effectons to their length (calculated, using eq.4.63);
(c) - the space between centers of primary [tr] effectons (in accordance to eq.4.62);
(d) - the ratio of space between primary [tr] effectons to their length (eq.4.63).

Two statements of Hierarchic model of consciousness are important:

1. The ability of intra-MT primary water effectons (tr and lb) for superradiation of six 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, also responsible for the distant, nonlocal interaction between microtubules. In accordance to superradiation mechanism 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 the model of MT’s as wave guide of superradiation for longitudinal photons, proposed by M. Jibu, S. Hagan, K. Yasue, et al., (1994). The difference of our approach from the latter one is that we assume in MT the existence of ”transverse” radiation of IR photons as well as ”longitudinal” ones. In our model the density of electromagnetic energy 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.

III. THE SYSTEM OF 3D STANDING WAVES, PRODUCED BY MICROTUBULES

The most probable length of microtubules (l) satisfy the conditions of standing electromagnetic wave, corresponding to librational longitudinal IR photons, radiated by primary effectons:

\[
l_{lb} = \kappa \frac{\lambda_{lb}}{2} = \frac{\kappa}{2n\pi lb} \quad (3.1)
\]
The similar dimension for translational IR photons is:

\[ l_{tr} = \kappa \frac{\lambda_{tr}^{\nu}}{2} = \frac{\kappa}{2n\nu_{tr}^{\nu}} \]  

(3.2)

here \( \kappa \) is the integer number; \( \lambda_{lb}^{\nu} \) and \( \lambda_{tr}^{\nu} \) are the librational and translational IR photons wave length:

\[ \lambda_{lb}^{\nu} = (n\nu_{lb}^{\nu})^{-1} \approx 10^5 \text{Å} = 10\mu \]
\[ \lambda_{tr}^{\nu} = (n\nu_{tr}^{\nu})^{-1} \approx 3.5 \cdot 10^5 \text{Å} = 35\mu \]

where: \( n \approx 1.33 \) is a refraction index of water; \( \nu_{lb}^{\nu} \approx (700 - 750) \text{cm}^{-1} \) is wave number of librational photons and \( \nu_{tr}^{\nu} \approx 200 \text{cm}^{-1} \) is the wave number of translational photons.

When condition (3.1) of standing waves is violated, i.e. \([\kappa]\) is non-integer, then the probability of IR radiation of librational photons increases strongly.

Deviation of \([\kappa]\) from integer values due to change of microtubules length as a result of electrostriction, induced by electric field or as a result of Ca\(^{2+}\), induced disassembly in the process of nerve excitation, - should be accompanied by corresponding oscillations of microtubules radiation.

Role of electromagnetic, acoustic and gravitational 3D standing waves in the adaptive reaction of nerve cells to excitation

In the normal cells, microtubules grow from the cell center to the cell periphery. In the animals cell center the pair of centrioles is placed. In the center of plant cells the centrioles are absent, only 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 (Fig. 3), i.e. two centriole are a source of: \((2 \cdot 27 = 54)\) microtubules. The centriole length is about 3000 Å and its diameter is 1000 Å.

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:

\[ v_d = \frac{9}{4\pi} \frac{\lambda_{lb}^{3}}{\lambda_{tr,lb}^{\nu}} \]

where: \((\lambda_{lb})_{lb} \sim 10^5 \text{Å}\) and \((\lambda_{tr})_{tr} \sim 3.5 \cdot 10^5 \text{Å}\)
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 correlated \((a \equiv b)_{lb}^{1,2,3}\) transitions of the effectons. The resonance superradiation or absorption of a number of librational photons \((3q)\) in the process of above transitions, is dependent on the number of primary \(lb\) effectons \((q)\) in the internal hollow core of a microtubule:

\[ q \sim \frac{[L^*]}{L_{\parallel}} \]  

(3.3)

where: \([L^*]\) is the length of microtubule;
\[ L^{lb}_{\parallel} \simeq 3.5 \cdot l^{lb}_{ef} \sim 80\AA \] is the approximate space between internal water primary librational effectons;
\[ l^{lb}_{ef} \sim 23\AA \] is the edge length of the primary \(lb\) effecton in MT at \(36^0\)C.

The value of \(q\) in (3.3) - determines the intensity (amplitude) of coherent longitudinal librational IR photons radiation from microtubule with length \(L^*\), for the case, when condition of standing waves (3.1) is violated. The frequency of this radiation is represented by eq.(3.5).

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).

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. This becomes possible, when the condition of standing waves for longitudinal \( lb \) photons in MT is violated.

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 physico-chemical phenomena:

- Nonmonotonic distribution of intra-cell water viscosity and diffusion processes in cytoplasm due to corresponding nonmonotonic spatial distribution of macrodeformons (sections 11.6; 11.8 of book: Kaivarainen 1995 and "New articles" in http://www.karelia.ru/~alexk);

- 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 also. The activity of numerous oligomeric allosteric enzymes could be regulated also in such a way.

The system of coherent electromagnetic 3D standing waves (primary deformons) is interrelated with that of acoustic and gravitational 3D waves, in accordance with our model.

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.

The constant of \((a \leftrightarrow b)\) equilibrium of primary librational effectons

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

(3.4)

and that of \((A^* \leftrightarrow B^*)\) equilibrium of supereffectons are dependent on the structure and dynamics of \(\alpha\beta\) tubulin pairs forming MT walls.

This equilibrium is interrelated, in turn, with \(lb\) photons frequency \((\nu_{lb})^{1,2,3}\):

\[
[\nu_{lb} = c(\bar{\nu})_{lb} = (V_b - V_a)_{lb}/h]^{1,2,3}
\]

(3.5)

which is determined by the difference of potential and total energies between \((b)\) and \((a)\) states of primary effectons in the hollow core of microtubules:

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

(3.6)

\((\bar{\nu})_{lb}^{1,2,3}\) is the librational band wave number.

The refraction index \((n)\) and dielectric constant of the internal water in MT depends on \([a \leftrightarrow b]\) equilibrium of the effectons because the polarizability of water and their interaction in \((a)\) state are higher, than that in \((b)\) state (see Articles at: www.karelia.ru/~alexk).

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

The normal nerve cell contains few dendrites, increasing the surface of cell’s body. It is enable to form synaptic contacts for reception the information from thousands of other cells. Each neurone has one axon for transmitting the ”resulting” signal in form of the electric impulses from the ends of axons of cells-transmitters to neuron-receptor.

The synaptic contacts, representing narrow gaps (about hundreds of angstrom wide) could be subdivided on two kinds: the direct-electric and more universal - chemical ones. In chemical synapsis the signal from the end of axon - is transmitted by neuromediator, i.e. acetylholine. The neuromediator molecules are stored in synaptic bubbles near presynaptic membrane. The releasing of mediators is stimulated by ions of \(Ca^{2+}\). After diffusion throw the synaptic gap mediator form a specific complexes with receptors of post synaptic membranes on the surface of neurons body or its dendrites. Often the receptors are the ionic channels like \((Na^+, K^+)\)- ATP pump. Complex - formation of different channels with mediators opens them for one kind of ions and close for the
other. Two kind of mediators interacting with channels: small molecules like acetilholine, monoamines, aminoacids and big ones like set of neuropeptides are existing..

The quite different mechanism of synaptic transmission, related to stimulation of production of secondary mediator is existing also. For example, activation of adenilatcyclase by first mediator increases the concentration of intra-cell cyclic adenozin-mono-phosphate (cAMP). In turn, cAMP can activate enzymatic phosphorylation of ionic channels, changing the electric properties of cell. This secondary mediator can participate in a lot of regulative processes, including the genes expression.

In the normal state of dynamic equilibrium the ionic concentration gradient producing 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 very important for regulative processes \(Ca^{2+}\) (about 10\(^{-3}\)M) is much higher than in cytosol (about 10\(^{-7}\)M). Such a big gradient provide fast and strong increasing of \(Ca^{2+}\) internal concentration after activation of corresponding 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 50-100mV. As far the thickness of membrane is only about 5nm or 50Å it means that the gradient of electric tension is about:

\[
100,000 \text{ V/sm}
\]

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.

The potential of action and nerve impulse can be excited in neuron - receptor only if the effect of depolarization exceeds certain threshold.

In accordance to our Hierarchic model of consciousness (HMC) three most important consequences of neuron's body polarization can occur:
- reorganization of MTs system and ionic channels activity, accompanied by short-term memory emergency;
- reorganization of synaptic contacts on the surface of neuron and its dendrites, leading to long-term memory;
- generation of the nerve impulse, transferring the signal to another nerve cells.

Propagation of nerve signal in axons may be related to intracellular water activity \(a_{H_2O}\) decreasing due to polarization of membrane. As a result of
feedback reaction the variation of \( a_{H_2O} \) induce the \([\text{opening/closing}]\) of the ionic channels, thereby stimulating signal propagation.

We suppose that the change of clusterphilic interaction of ordered water between inter-lipid tails in nonpolar central regions of biomembranes, could be responsible for lateral signal transmission in membranes (Kääväräinen, 1985, 1995). Such mechanism can provide distant cooperative interaction between different receptors and channels on cell surface.

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 electric component of electromagnetic field, which accompanied the nerve excitation. In turn, dynamics of microtubules hollow core affects the properties of internal ordered water.

For example, shift of the \([\text{open} \Leftrightarrow \text{closed}]\) states equilibrium of cavity between \( \alpha \) and \( \beta \) tubulins to the less stable open one in a course of excitation should lead to:

[I]. Increasing the dimensions and life-time of coherent clusters, represented by primary \( lb \) effectons in the open states of inter \( \alpha-\beta \) tubulins nonpolar cavities;

[II]. Destabilization of MT, increasing the probability of its disassembly;

[III]. Stimulation the distant interaction between MT of different neurons as a result of increased frequency and amplitude/coherency of IR librational photons;

[IV] The rightward shift of \( (A^* \Leftrightarrow B^*) \) equilibrium could be stimulated by the elevation of \( lb \) IR- photons density due to enhancement of superradiance effect and IR photons pumping. This shift increases the probability of cavitational fluctuation of the intra MT water and reversible disassembly of microtubules.

The lower stability of MTs in the nerve cell body as respect to its bundles in axon or in cilia is a result of fact that microtubules in bundles are interconnected by "handle"-like proteins (deneins) and other microtubule associated proteins (MAP).

Twisting of the centrioles of distant interacting cells and bending of MTs can occur after \([\text{gel}\rightarrow\text{sol}]\) transition. This tuning is necessary for enhancement of the number of MTs with the parallel orientation, most effective for their exchange interaction by means of 3D coherent IR photons and vibro-gravitational waves.

Reorganization of actin filaments and MTs system should be accompanied by corresponding changes of neuron’s body and its dendrites shape and activity of certain ionic channels and synaptic contacts redistribution;

This stage is responsible for long-term memory emergency.

At \([\text{sol}]\)-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. Decay of neuron’s response is termed "adaptation". This response adaptation is accompanied
by MTs-adaptation, i.e. their reassembly in conditions, when concentration of $Ca^{2+}$ tends to minimum. The reverse [sol$\rightarrow$gel] transition stabilize the new equilibrium state of given group of cells.

The described hierarchic sequence of stages: from molecular Bose condensation to synaptic reorganization, responsible for described cycles of nerve cells, reflects the idea of our model of consciousness.

The equilibrium constants of the intra-microtubule water convertons ($K_{[1]}$) and supereffects ($K_{A\leftrightarrow B}$), which determines the probability of cavitational fluctuations - superdeformons may also be dependent on following external as respect to MT factors:

- the dynamics of MT (+) ends, fixed on cell’s membranes, depending on concentration of $Ca^{2+}$, water activity ($a_{H_2O}$) and cells swelling;
- the frequency and intensity of the resonant IR-radiation of MTs, external as respect to selected cell:
  - resonant opto-acousto-gravitational fields, produced by water of MTs of other cells and large-scale (LS) and small scale (SS) dynamics of $\alpha\beta$ tubulin pairs.

The LS-dynamics of tubulin dimers represent the change of "bending" angle between $\alpha$ and $\beta$ tubulins of about 21° (Melki et al., 1989), corresponding to fluctuation of the inter-tubulins cavity between closed (A) and open (B) states. Such bending is a result of macroconvertons (flickering clusters) excitations with frequency: $(10^6 - 10^7)$ Hz (see Fig.48c).

The [assembly $\rightleftharpoons$ disassembly] dynamic equilibrium of the actin filaments and MT subsystems in cells in terms of colloid chemistry represents [coagulation $\rightleftharpoons$ peptization] or [gel $\rightleftharpoons$ sol] equilibrium. The increasing of cell’s volume, accompanied the MTs orchestrated disassembly is a result of cell "swelling" due to osmotic diffusion of water from the extracell medium. The decreasing of water activity in cell, inducing such osmose, is a consequence of increasing of "bound" or "hydration" water fraction after microfilaments and MT disassembly to huge number of subunits.

The nerve cell body and dendrites swelling will induce 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. However, the "sensitivity" of certain ionic channels might be changed as a result of MTs and synaptic systems perturbation. This could be responsible for short-term memory.

The cooperative disassembly/assembly of MTs, induced by cavitat-
tional fluctuations (superdeformons) can be accompanied by coherent "biophotons" emission/absorption in the ultraviolet (UV) and visible range due to water molecules [dissociation $\leftrightarrow$ recombination] reaction in a course of intra-MT water cavitation fluctuations. These high-frequency coherent photons exchange, like the IR photons and high-frequency nerve impulses, propagating via axons - may be responsible for synchronized firing of distant neuron ensembles in head brain (Singer, 1993). 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 $\leftrightarrow$ evaporation], corresponding in our model to [lb/tr] convertons excitation.

One of the important idea of HMC is that collective interactions of distant neurons in head brain could be realized not only by means of conventional nerve impulse via axons. It happens more effectively by combination of simultaneous cells bodies depolarization with resonant quantum exchange between their MTs with similar orientation.

4.1 The entropy-driven information processing

It leads from HMC is that changes of systems of electromagnetic, acoustic and gravitational 3D standing waves and corresponding holograms in the ensemble of nerve cells, produced by the orchestrated internal water of MTs in course of braining, enhance the quantum exchange between neurons.

This process induces redistribution of probabilities of different water excitations in huge number of microtubules. It means corresponding change of informational entropy $<I>$ in accordance with known relations (Kaivarainen 1995; 1997):

$$<I> = \sum \frac{P_i \ln(1/P_i)}{P_i} = -\sum_i P_i \ln(P_i)$$  \hspace{1cm} (4.1)

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

$$P_i = \frac{\exp(-\frac{E_i}{kT})}{\sum \exp(-\frac{E_i}{kT})}$$ \hspace{1cm} (4.2)

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

$$S(e.u.) = k \cdot lnW = (k \cdot ln2)I = 2.3 \cdot 10^{-24} I(\text{bit})$$ \hspace{1cm} (4.3)

where: statistical weight of macrosystem:
where total number of internal water molecules in macrosystem of interacting MT is:
\[ N = N_1 + N_2 + \ldots + N_q; \]

\[ [q] \text{ is number of non degenerated states of 24 quasiparticles of intra MT water.} \]

The reduced information of condensed matter [see Chapter 14, eq.14.27b in book: Kaivarainen 1995; 1997] gives the quantitative characteristic not only about quantity (I) but also about the quality of the information:

\[ <I_q> = -\frac{N_0}{V_0} \sum_i P_i \log_2 (P_i)/n_i \]  \hspace{1cm} (4.5)

where \( N_0 \) and \( V_0 \) are the Avogadro number and molar volume; \( n_i \) is a concentration of excitation of (i)-type.

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 MT system with volume \( (v_i = 1/n_i) \).

The factors, affecting the equilibrium constant of two-state excitations of water in MT

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

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 \((K_{\pi \leftrightarrow \tau})_{tr,lb}\) and that of supereffectons \((K_{\Lambda \leftrightarrow B})\) are presented below:

\[ (K_{a\leftrightarrow b})_{tr,lb} = \exp[-h(\nu_a - \nu_b)/kT]_{tr,lb} = \exp[-h\nu_p/kT]_{tr,lb} \]  \hspace{1cm} (4.6)

\[ K_{tr \leftrightarrow lb} = (K_{a\leftrightarrow b})_{tr} \cdot (K_{a\leftrightarrow b})_{lb} = \exp[-h(\nu_{tr} + \nu_{lb})/kT]_{lb} \]  \hspace{1cm} (4.7)

\[ (K_{\pi \leftrightarrow \tau})_{tr,lb} = \exp[-h(\nu_{\pi} - \nu_{\tau})/kT]_{tr,lb} = \exp[-h\nu_{ph}/kT]_{tr,lb} \]  \hspace{1cm} (4.8)

\[ K_{A \leftrightarrow B} = \exp[-h(\nu_A - \nu_B)/kT] = \]

\[ (K_{A\leftrightarrow B})_{tr} \cdot (K_{A\leftrightarrow B})_{lb} = [K_{a\leftrightarrow b} \cdot K_{\pi \leftrightarrow \tau}]_{tr} \cdot [K_{a\leftrightarrow b} \cdot K_{\pi \leftrightarrow \tau}]_{lb} \]  \hspace{1cm} (4.9)
The primary effectons equilibrium constants \((K_{\alpha \leftrightarrow b})_{tr,lb}\) 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 \(lb\) effectons.

We have at least five defined parameters, involved in the quantum processes of nerve activity in our model:

1. Intensity of IR superradiance and vibro-gravitational waves, radiated by MT system;
2. Frequency of coherent IR radiation, produced by water of the microtubule system, responsible for distant cooperation between microtubules;
3. The life-time of primary \(lb\) effecton \((\tau_{lb})\) responsible for [order \(\leftrightarrow\) disorder] equilibrium of water in MT, interrelated directly with \([B \leftrightarrow A]\) equilibrium of nonpolar cavities between \(\alpha\) and \(\beta\) tubulins;
4. Frequency \((\nu_{A^* \leftrightarrow B^*})\) of a big 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;
5. Frequency and intensity of high-frequency ”biophotons”, resulted from recombination of water molecules after their dissociation in a course of intra-MT water cavitation 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; ”New articles” in: http://www.karelia.ru/~alexk). 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 by electromagnetic and, possibly, gravitational primary deformons. In this case, autowaves represent spatially distributed oscillations of \([A^* \leftrightarrow B^*]\) 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, related to oscillation of

\[ A^* \leftrightarrow B^* \text{ and MTs } [assembly \leftrightarrow disassembly] \]

equilibrium in a big groups of nerve cells, include two possible phenomena on mesoscopic and macroscopic scale:
1. Polarization/depolarization of neurons;
2. Collective activation/relaxation of synaptic connections, accompanied by [assembly/disassembly] of MTs system.

As was mentioned above, both of these processes can be accompanied by the change of volume and shape of nerve cell body.

**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.

Resonance energy exchange between systems of microtubules of different "normal" cells, leading to the change of \( K_{A^* \leftrightarrow B^*} \) and \( a_{H_2O} \) can be responsible also for differentiation and morphogenesis of cells.

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

Our model consider fluctuations and dissipation, stimulating [gel \( \Rightarrow \) 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 - make the process of braining NON-DETERMINISTIC and means its ability for creativity. 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 INTUITION from such point of view means the ability to choose one right solution (rigorously inadequate) from huge number of wrong, but adequate to the available at the moment information. It looks that associative memory, helping such choose, is the most probable background for INTUITION.

Von Neumann model of cellular automata was used by Hameroff et al. as a background for description of information processing. The
essential features of cellular automata after Hameroff et al. (1992, 1994) are the following:

1. At a given time, each "cell" is in one of a number of finite states (usually two);
2. The "cells" are organized according to a fixed geometry;
3. Each "cell" communicates with other cells in its neighborhood only. The size and shape are the same for all "cells";
4. There is a universal clock. The each "cell" may change to a new state at each tick of the clock, depending on its present state and the states of its neighbors.

The time step of cellular automata clock in Hameroff’s model is related with tubulins, composing MT, conformational changes with coherent phonons frequency \((10^{10} – 10^{11}) \text{ Hz}\), proposed by Frölich (1968, 1975). Frölich assumed that acousto-conformational transitions are coupled to charge redistributions, that accompanied the dipole oscillations or electron movements in nonpolar regions of protein with a low dielectric constant. Hameroff assumed that such conformational transitions induce the acoustic waves, propagating across microtubule diameter, providing ”clocking frequency” for cellular automata.

In our approach the ”clocking frequency" can be related to that of \([A^* \leftrightarrow B^*]\) transitions of supereffectons, having the order of \(10^4 \text{ Hz}\). The role of ”cell” in cellular automata could be played by definite parts of microtubules, changing as a result of superdeformons excitation, between nodes of the standing wave length of librational IR photons \((\sim 10^5 \text{ A})\). The number of hierarchic cellular automata can be very high.

The notion of gliders, as of patterns, moving through the medium of cellular automata unchanged, i.e. without dissipation is important for interaction between number of ”cells”.

In our model the PRIMARY (electromagnetic, gravitational) deformons for one side and SECONDARY acoustic deformons - could be termed the long distance and short distance gliders correspondingly.

V. 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

$$\Delta M_{\text{col}} \sim 10^{19} D$$ (5.1)

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, 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.

However, we explain the selection of certain configurational space of huge number of the excited neurons ensemble as a result of spatial tuning of MTs orientations and corresponding redistribution of synaptic contacts due to distant (not nonlocal) electromagnetic and vibro-gravitational resonant interactions between MTs.

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

$$m_{\text{H}_2\text{O}} \sim 10^8 D$$

In accordance with our calculations for bulk water, the fraction of molecules in composition of primary $tr$ effectons is about 23% and that in composition of primary $lb$ effectons is about ten times less (Fig.4). In MTs due to clusterphilic interaction, the $[lb]$ 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:

$$\Delta m_{\text{H}_2\text{O}} \simeq 10^6 D$$

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 MTs, we assume that the maximum increasing of mass of primary $lb$ effectons in one cell could be:

$$\Delta M_{\text{H}_2\text{O}} \sim 50 \cdot \Delta m_{\text{H}_2\text{O}} = 5 \cdot 10^7 D$$ (5.2)
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

$$N_{\text{col}} \sim (\Delta M_{\text{col}}/\Delta M_{H_2O})$$  \hspace{1cm} (5.3)

![Graph showing the ratio of water fractions](image)

**Fig. 4.** Calculated ratio of water fractions involved in primary [lb] effectons to that, involved in primary [tr] effectons for the bulk water.

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

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

The [gel–sol] transition of simultaneously excited neurons body, followed by "tuning" of their microtubules orientations, is another explanation of coherent "collapsing" of neurons group, leading to "choosing" of one state from huge number of possible, after our HMC.

Our model agree 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.

VI. Distant [cell-cell] interaction by means of high-frequency biophotons in our model

We propose that all the intra-cell processes, accompanied by drastic reorganization of the actin filaments and microtubules systems, i.e. collective disassembly (supercatastrophe), leading to [gel-sol] transition. This process can be stimulated by intra-MT water superdeformons, which are accompanied by high-frequency (UV, visible) biophotons radiation. It is a result of water molecules recombination after their dissociation to the protons and hydroxyl groups, accompanied by superdeformons and cavitational fluctuations.

It is possible that dynamic reorganizations of chromatin fibrils with diameter 30nm (elongated complexes of DNA with proteins-histones), also can influence on water and other molecules recombination probability and biophotons emergency.

Large-scale (LS) dynamics of the chromatin fibrils (CF) has a few hierarchic levels.

The first one is due to relative fluctuations of nucleosomes, linked to each other with flexible regions of "free" DNA. The width of cavities between of nucleosomes is about 11A. It is close to that of proteins domains and linear dimension of water lb effectons at physiological temperature.(see http://www.karelia.ru/~alexk/new_articles)

The second level of large scale (LS) dynamics of CF can be related to reversible cooperative dissociation of chromatin domains (composed from few nucleosomes) and histone H1, leading to unfolding of these domains.

The third level of LS dynamics of CF is assumed to occur in a course of relative fluctuations of big (400nm) loops of chromatin fibril.

Each level of LS dynamics of CF is correlated with water density fluctuations like macroconversion and superdeformons (see Appendix).

Biophotons radiation, related to MTs and chromatin large-scale dynamics, their [assembly=disassembly] could happen in a course of cells division or poisoning. We suggest that this radiation could be responsible for "mitogenic rays", discovered by Gurvich in 1920. Later such effect was confirmed on division of synchronized yeast cultures. The "Degradation radiation" was observed on strongly damaged or dying cells, regardless of the cause of death.

The "cytotoxic effect", revealed by Kaznacheev and others (1976) involves interaction between two cell cultures separated by quartz or regular glass. In such a system a poisoned, dying culture shown to be able to communicate via quartz glass only with normal cell culture initiating its pathological changes and even death. These experiments point to ultraviolet range of biophotons, radiated by dying culture, producing cytotoxic effect in distant healthy...
The ultra-weak radiation of *coherent* biophoton by different living organisms was profoundly studied by group of F. Popp (1992).

Our model explains the emission of visible and UV-biophotons as a result of water molecules recombination, accompanied the super-catastrophe of microtubules systems of cells.

The *dissociation* = *recombination* of [anion–cation] bridges of chromatin, induced by LS-dynamics like [DNA + H1 hystons] complexes reversible disassembly, also could be accompanied by biophotons radiation.

In course of cells division both kinds of these interrelated processes make contribution in coherent biophotons emission.

The distant action of UV-biophotons on other cells could be a consequence of increasing of *water* molecule dissociation probability to proton (H\(^+\)) and hydroxyl group (HO\(^-\)) due to photo-activation:

\[
\hbar \nu_p + H_2O \rightarrow [H_2O]^+ = HO^- + H^+ \quad (6.1)
\]

Shifting the equilibrium of this reaction to the right, leads to perturbation of water structure in microtubules as a result of strong solvatation of protons (H\(^+\)). In turn, this perturbation destabilize the *primary librational effectons*, increase the probabilities of *superdeformons* excitation and disassembly of microtubules and chromatin.

The shift of equilibrium [assembly ⇋ disassembly] of group of the *actin filaments, microtubules and chromatin fibrils* to the right in one conditions will stimulate cell division (when cell is ready for it), in other conditions - its morphogenic reorganization (differentiation) and in another ones - death of cell.

**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:

1. The change of the electric component of cell’s electromagnetic field as a result of neuron depolarization;
2. Shift of \(A ⇋ B\) equilibrium between the closed (A) and open to water (B) states of cleft, formed by α and β tubulins in microtubules (MT) to the right due to the piezoelectric effect;
3. Increasing the life-time and dimensions of coherent ”flickering” water clusters, representing the 3D superposition of de Broglie standing waves of \(H_{2}O\) molecules with properties of Bose-condensate (effectons) in hollow core of MT. This process is stimulated by the open nonpolar clefts of tubulin dimers in MT with regular 80Å spacing;
4. Increasing the superradiance of coherent IR photons induced by synchronization of quantum transitions of the *effectons* between acoustic and optic like states;
5. Opening the potential dependent Ca$^{2+}$ channels and increasing the concentration of these ions in cytoplasm;

6. Activation of Ca$^{2+}$ - dependent protein gelsolin, which induce fast disassembly of actin filaments and [gel-sol] transition, decreasing strongly the viscosity of cytoplasm and water activity;

7. Spatial "tuning" of quasi-parallel MTs of distant simultaneously excited neurons due to distant electromagnetic and vibro-gravitational interaction between them and centrioles twisting;

8. The coherent volume/shape pulsation of big group of depolarized cells as a consequence of (actin filaments+MTs) system disassembly and [gel→sol] transition. It happens as a result of [MF+MT] system reversible disassembly to huge number of subunits and increasing of water fraction in hydration shell of actin and tubulin subunits due to increasing of their surface. This should decrease the water activity in cytoplasm and increase the passive osmotic diffusion of water from the external volume to the cell.

This stage should be accompanied by four effects:

(a): Increasing the volume of the nerve cell body;

(b): Disrupting the (+) ends of MTs with cytoplasmic membranes, making MTs possible to bend in cell and to collective spatial tuning of huge number of MTs in the ensembles of even distant excited neurons;

(c) Origination of new MTs system switch on/off the ionic channels and change the number and properties of synaptic contacts;

(d): Decreasing the concentration of Ca$^{2+}$ to the limit one when its ability to disassembly of actin filaments and MT is stopped and [gel⇌sol] equilibrium shifts to the left again, stabilizing a new MTs and synaptic configuration.

This cyclic consequence of quantum mechanical, physico-chemical and nonlinear events can be considered as elementary act of memory and consciousness realization. This act can be as long as 500 ms, i.e. half of second.

The elementary act of consciousness include a stage of coherent electric firing in brain (Singer, 1993) of distant neurons groups with period of about 1/40 sec.

Probability of superdeformons and cavitational fluctuations increases after [gel→sol] transition. This process is accompanied by high-frequency (UV and visible) "biophotons" radiation due to recombination of part of water molecules, dissociated as a result of cavitational fluctuation.

The dimension of IR superdeformon 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 is that the resonance wave number of excitation of superdeformons, leading from our model is equal to 1200 (1/cm).
The experiments of G. 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.

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.
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 (hνph) exchange between (αβ) clefts due to [lb/tr] conversions, corresponding to water clusters, "flickering", in-phase to [B ⇔ 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 (α ⇔ β) transitions of water primary librational effectons, localized in the open B- states of (αβ) clefts.
When the neighboring ($\alpha\beta$) clefts has the alternative open and closed states like on Fig 5, the general spatial structure remains straight. However, when $[A \Leftrightarrow B]$ equilbrium 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.

**Experimental data, confirming the HMC**

There are some experimental data, which support the role of microtubules in the information processing. Good correlation was found between the learning, memory peak and intensity of tubulin biosynthesis in the baby chick brain (Mileusnic et al. 1980). When baby rats begin their visual learning phase after they first open eyes, neurons in the visual cortex start to produce vast quantities of tubulin (Cronley- Dillon et. al., 1974). Sensory stimulation of goldfish leads to structural changes in cytoskeleton of their brain neurons (Moshkov et al., 1992).

There is evidence for interrelation between cytoskeleton properties and nerve membrane excitability and synaptic transmission (Matsumoto and Sakai, 1979; Hirokawa, 1991). It has been shown, that microtubules can transmit electromagnetic signals between membranes (Vassilev et al., 1985).

Desmond and Levy (1988) found out the learning-associated change in dendritic spine shape due to reorganization of actin and microtubules containing, cytoskeleton system. After ”learning” the number of receptors increases and cytoskeleton becomes more dense.

Other data suggest possibility that cytoskeleton regulates the genome and that signaling along microtubules occurs as cascades of phosphorylation/dephosphorylation linked to calcium ion flux (Puck, 1987; Haag et al, 1994).

The frequency of superdeformons excitations in bulk water (see Fig.48 d in book: Kaivarainen 1995) at physiological temperature ($37^0C$) in bulk water is around:

$$\nu_S = 3 \cdot 10^4 \text{ s}^{-1}$$

The frequency of such cavitational fluctuations of water in MT, stimulating in accordance to our model cooperative disassembly of MT, could differ a bit from the above value for bulk water. The difference is due to stabilizing influence of cavities between $\alpha$ and $\beta$ tubulins on coherent water clusters (primary lb effectons).

Our model predicts that if the neurons or other cells, containing MTs, will be treated by acoustic or electromagnetic field with resonance frequency of intra-MT water ($\nu_{\text{res}} \sim \nu_S^{MT} \geq 1 \cdot 10^4 \text{ s}^{-1}$), it can induce simultaneous disassembly of number of MTs, responsible for maintaining the specific cell volume and geometry. As a result, it activates the neuron's body volume/shape pulsation.

**Such external stimulation of supercatastrophe has two important consequences:**
- The first one is generation of strong high-frequency nerve impulse, propagating via axons and exciting huge number of other nerve cells, i.e. distant nerve signal transmission in living organism;

- The second one is stimulation the leaning process as far long-term memory in accordance to HMC, is related to synaptic contacts reorganization, accompanied the neuron volume/shape pulsation.

The first of these two consequences of HMC is in accordance with phenomena of "ultrasound hearing", discovered by P. Flanagan and used in his invented device: "Neurophone" (Flanagan, 1996). It consists of a (30-50) kHz amplitude modulated by ordinary acoustic waves ultrasonic oscillator that generated 3.000 volts peak across two plastic insulated electrodes that were placed in contact with skin. It was shown that the skin under the electrodes was caused to vibrate by the energy field. Even some totally nerve-deaf people could hear with Neurophone.

The ordinary audio frequencies are in the range of 20 Hz to 20.000 Hz. These ordinary audio frequencies are percepted by cochlea or inner ear through the air or through the bones.

Lehardt et al. (1989) supposed that ultrasonic vibrations are perceptive by another channel: tiny gland in the inner ear known as the Saccule. It looks that Saccule may have a dual functions of detection gravity and auditory signals. Cochlea could be a result of Saccule evolution in mammals.

Lenhardt and colleagues constructed the an amplitude modulated by audio-frequencies ultrasonic transmitter that operated at frequencies: (28-90) kHz. The output signal from their device was attached to the deaf people heads by means of piezo-electric ceramic vibrator. All people "heard" the modulated signal with clarity.

The second mentioned above consequence of HMC also is confirmed by means of digital Neurophone version: Thinkman Model 50, developed by Flanagan. It was demonstrated that if the educational tapes were played throw device, the information is very rapidly incorporated into long-term memory (Flanagan, 1996).

Another very interesting optical phenomena, confirming HMC, was revealed by Flanagan also. It is a stimulation of light emission (visible and may be UV biophotons, affecting the photo film) by the human skin and any living things as well, induced by Neurophone’s radio-frequency (RF): \(4 \times 10^4\) Hz (Begich, 1996).

It is in accordance with consequence of HMC that external fields, inducing cavitational fluctuations and MTs supercatastrophe, should lead to enhancement of "biophotons" radiation in visible and UV regions, emitted as a result of recombination reaction:

\[
HO^- + H^+ \xrightarrow{h\nu} H_2O
\]  

We can predict one more important consequence of HMC. Excitation of water superdeformons in MTs, leading to their collective disassembly (supercatastrophe), cell’s volume/shape pulsation and
generation of high-frequency nerve impulse - could be stimulated not only by US acoustic and RF electromagnetic signals, but as well by coherent laser emitted IR photons with frequency, corresponding to excitation energy of superdeformons.

We can calculate the photons frequency equal to

$$\nu_p^S = c \cdot \nu_p^S = (3 \cdot 10^{10}) \cdot 1200 = 3.6 \cdot 10^{13} \text{c}^{-1} \quad (6.3)$$

and wave length:

$$\lambda_p^S = c / (n_{H_2O} \cdot \nu_p^S) \simeq 6.3 \cdot 10^{-4} \text{cm} = 6.3\mu \quad (6.4)$$

where: $\nu_p^S = 1200 \text{cm}^{-1}$ is wave number, corresponding to energy of superdeformons excitation;

$n_{H_2O} \simeq 1.33$ is refraction index of water.

The idea of new device: Audio/Video Signals Skin Transmitter is proposed by us. In this device the laser beam with corresponding to (6.3) frequency and ultraweak intensity will 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 chacras, 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 chacras 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 $[\alpha \text{ or } \beta]$ rhythms, applied to scull and chacras, 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 predictable. The coherent electromagnetic radiation of these nodes, including the acupuncture one can be responsible for so-called aura.

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 the volume of superdeformons, inducing reversible disassembly of MTs. 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 will be a good additional evidence in proof of HMC and useful for lot of people with corresponding diseases.

The ways for experimental verification of HMC in vitro

It is possible to suggest some experimental ways of verification of our HMC using model systems. The important point of HMC is stabilization of highly ordered water clusters (primary librational effectons) in the hollow core of microtubules. One can predict that in this case the IR librational and translational bands of water in the oscillatory spectra of model system, containing sufficiently high concentration of MT, must differ from IR spectra of bulk water as follows:

- the shape of $lb$ band in the former case must contain 2 components: the first one, big and broad, like in bulk water and the second one small and sharp, due to increasing coherent fraction of $lib$ effectons and superradiance;
- sound velocity in the system of microtubules must be bigger, than that in bulk pure water due to bigger fraction of ordered ice-like water;
- all the above mentioned parameters must be dependent on the external electromagnetic field, due to piezoelectric properties of MT;
- the irradiation of MTs system in vitro by ultrasonic or electromagnetic fields with frequency of superdeformons excitation of the internal water of MTs at physiological temperatures ($25 - 40^0C$):

$$\nu_s = (2 - 4) \cdot 10^4 \text{ Hz}$$

have to lead to increasing the probability of disassembly of MTs, induced by cavitational fluctuations. The corresponding effect of decreasing turbidity of MT-containing system could be registered by light scattering method.

Another consequence of superdeformons stimulation by external fields could be the increasing of intensity of radiation in visible and UV region due to emission of corresponding "biophotons" as a result of recombination reaction of water molecules:

$$\text{HO}^- + H^+ \stackrel{hv}{\rightarrow} H_2O$$
Cavitational fluctuations of water, representing in accordance to our theory superdeformons excitations, are responsible for dissociation of water molecules, i.e. elevation of protons and hydroxyls concentration.

The coherent transitions of \((\alpha/\beta)\) dimers, composing MTs, between "closed" (A) and "open" (B) conformers with frequency \((\nu_{mc} \sim 10^7 \, s^{-1})\) are determined by frequency of water macroconvertons (flickering clusters) excitation, localized in cavity between \(\alpha\) and \(\beta\) tubulins. If the charges of (A) and (B) conformers differ from each other, then the coherent (A\(\Rightarrow\)B) transitions generate the vibro-gravitational and electromagnetic field with the same radio-frequency. The latter component of biofield could be detected by corresponding radio waves receiver.

The amplitude of corresponding vibro-gravitational waves (VGW) is not dependent on difference in electric charge, but on mass and accelerations of \(\alpha\) and \(\beta\) tubulins in course of (A\(\Rightarrow\)B) large-scale fluctuations.

The VGW generated by relative LS oscillations of nucleosomes in composition of chromatins fibrils and electromagnetic waves generated by second level of the fibrils LS dynamics, described above - also could be responsible for distant [cell-cell] interaction.

We can conclude that our Hierarchic theory of condensed matter and its application to water and biosystems - provide reliable models of informational exchange between different cells and correlation of their activity. Hierarchic model of consciousness is based on proposed quantum exchange mechanism of interactions between neurons, based on very special properties of microtubules, [gel-sol] transitions and interrelation between spatial distribution of MTs in neurons body and synaptic contacts on their surface.

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APPENDIX:

SUMMARY OF
NEW HIERARCHIC THEORY OF CONDENSED MATTER
by: Alex Kaivarainen

The basically new hierarchic quantitative theory, general for solids and liquids, is developed.

It is assumed, that unharmonic oscillations of particles in any condensed matter lead to emergency 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 modify, unify and develops strongly the Einstein’s and Debye’s models.

Collective excitations, like 3D standing de Broglie waves of molecules, representing at certain conditions the mesoscopic molecular Bose condensate, were analyzed, as a background of hierarchic model of condensed matter.

The most probable de Broglie wave (wave B) length is determined by the ratio of Plank constant to the most probable impulse of molecules, or by ratio of its most probable phase velocity to frequency. The waves B could be related to molecular translations (tr) and librations (lb).

As far the quantum dynamics of condensed matter did not follow in general case the classical Maxwell-Boltzmann distribution, 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 Bose condensation in solids and liquids at temperatures, below boiling point. It is one of the most important results of our theory, 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**, presenting the intermediate [a ↔ b] transition states of the tr and lb effectons;
4. **Deformons**, as the 3D superposition of IR electromagnetic or acoustic waves, activated by transitons and 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) could 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.

The liquids are semiclassical systems, as far their (tr) primary effectons contain less than one molecule and (lb) primary effectons - more than one molecule. The solids are quantum systems totally because both kind of the effectons (tr and lb) are molecular Bose condensates. These consequences of our theory are confirmed by computer calculations. The 1st order gas-liquid transition is accompanied by strong decreasing of rotational degrees of freedom due to emergency of primary (lb) effectons and liquid-solid transition - by decreasing of translational degrees of freedom due to Bose-condensation of primary (tr) effectons.

In general case the effecton can be approximated by parallelepiped
with ribs corresponding to de Broglie waves length in three selected directions (1, 2, 3), related to symmetry of molecular dynamics. In the case of isotropic molecular motion the effectons shape could be approximated by cube.

The edge's length of primary effectons (tr and lb) can be considered as the parameter of order.

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 the effectons has a common features with Fröhlich's polar mode.

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

Superposition (interception) of three internal standing IR photons of different directions (1,2,3) - forms primary electromagnetic deformons (tr and lb).

On the other hand, the [lb/tr] convertons and secondary transitions are accompanied by the density fluctuations, leading to absorption or radiation of phonons with corresponding frequencies.

Superposition - interception of standing phonons of 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 origination 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 $24 = 4!$ reflects the 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 any condensed matter.

The important positive feature of our hierarchic model of matter is that it does not need to use the semi-empiric intermolecular potentials for calculations, which are unavoidable in existing theories of many body systems. The potential
The energy of intermolecular interaction is involved indirectly in dimensions and stability of quasiparticles, introduced in our model.

The main formulae of theory are the same for liquids and solids and include following experimental parameters, which take into account their different properties:

1. Positions of (tr) and (lb) bands in oscillatory spectra;
2. Sound velocity;
3. Density;
4. Refraction index (extrapolated to the infinitive wave length of photon).

The knowledge of these four basic parameters at the same temperature and pressure makes it possible using our computer program, to evaluate more than 150 important characteristics of any condensed matter. Among them are such as: total internal energy, kinetic and potential energies, heat-capacity and thermal conductivity, surface tension, vapor pressure, viscosity, coefficient of self-diffusion, osmotic pressure, solvent activity, etc. Most of calculated parameters are hidden, i.e. inaccessible to direct experimental measurement.

The new interpretation and evaluation of Brillouin light scattering and Mössbauer effect parameters also are done on the basis of hierarchic model. Mesoscopic scenarios of turbulence, superconductivity and superfluidity are elaborated.

Some original aspects of water in organization and large-scale dynamics of biosystems: proteins, DNA, microtubules, membranes and regulative role of water in cytoplasm, cancer emergency, quantum neurodynamics, etc. are analyzed in the framework of Hierarchic theory.

Computerized verification of our Hierarchic concept of matter on examples of water and ice has been performed, using special computer program: Comprehensive Analyzer of Matter Properties (CAMP, copyright, 1997, Kaivarainen). The new opto-acoustical device (CAMP), based on this program, with possibilities much wider, than that of IR, Raman and Brillouin spectrometers, has been proposed (see URL: http://www.karelia.ru/~alexk).

It is a first theory enable to predict all known experimental temperature anomalies for water and ice. The conformity between theory and experiment is very good even without fit parameters.

Hierarchic mesoscopic concept makes a bridge between micro- and macro- phenomena, dynamics and thermodynamics, liquids and solids in terms of quantum physics.

0.0.1 References

Aksnes G., Libnau O. Temperature dependence of ether hydrol-
Alberts B., Bray D., Lewis J., Ruff M., Roberts K. and Watson
Albrecht-Buehler G. Surface extensions of 3T3 cells towards dis-
Albrecht-Buehler G. Rudimentary form of cellular "vision". Proc.Natl.Acad.Sci.USA
Aliotta F., Fontanella M.E., Magazu S. Sound propagation in
Amos L. A. and Klug A. Arrangements of subunits in flagellar
3d-Ed. Moscow, 1981.
Antonchenko V.Ya. Physics of water. Naukova dumka, Kiev,
1986.
Ashkroft N., Mermin N. Solid state physics. N.Y.:Helt, Rinehart
Athenstaedt H. Pyroelectric and piezoelectric properties of vert-
Audenaert R., Heremans L., Heremans K., & Engleborghs Y.
Secondary structure analysis of tubulin and microtubules with Ra-
Åkesson E., Hakkarainen A., Laitinen E., Helenius V., Gillbro T.,
Korppi-Tommola J., Sundström V. Analysis of microviscosity and
reaction coordinate concepts in isomerization dynamics described
by Kramers' theory.
Babloyantz A. Molecules, Dynamics and Life. An introduction
to self-organization of matter. John Wiley & Sons, Inc. New York,
1986.
Bardeen J., Cooper L.N., Schrieffer J.R. Phys. Rev., 108, 1175,
1957.
Bardeen J., Schrieffer J.R. Progr. Low. Temp. Phys, 3, 170,
1960.
Bednorz J.G., Muller K.A. Z.Phys.B. Condensed Matter, 64, 189,
1986.
Begich N. Towards a new alchemy. The millennium science.
Bershadsky and Vasiliev J.M. Cytoskeleton. In: Cellular Org-


43


Feynman R. Statistical mechanics.


Grebennikov V.S. Priroda i chelovek ("Svet"), (USSR), 1990, No.8, p.22.


Kramers H.A. Physika 1940, 7, 284.


Manning Jeane. The coming energy revolution. 1996.


Roberts J. and Wang F. Dielectric relaxation in water over the frequency range 13 ≤ f ≤ 18 GHz using a resonant microwave cavity operating in the $TM_{010}$ mode. J. Microwave Power and Electromagnetic Energy, 1993, 28, 196 – 205.


Umezawa H. Matsumoto H. and Tachiki. Thermo field dynamics and condensate states (North-Holland, Amsterdam, 1982).


