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# **Consciousness in the Universe is Tuned by a Musical Master Code: A Hydrodynamic Superfluid Quantum Space Guides a Conformal Mental Attribute of Reality. The Hard Problem in Consciousness Studies Revisited**

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## **Summary**

This review article submits an integral concept of information processing in the universe on the basis of a generalized musical (GM)-scale of discrete EMF frequencies. Meta-analyses of current biophysical literature revealed the effects of similar EMF frequency patterns in a wide range of animate and non-animate systems. This provided a novel conceptual bridge between living and non-living systems, being of relevance for the areas of biophysics, brain research, as well as for mechanisms of biological evolution. As to the latter aspect, the potential role of phyllosilicates (clay materials) in the generation of a primordial biofield is treated and seen as instrumental in a partially guided creation of first life. We hold, in general, that nature is guided by a discrete pattern of harmonic solitonic waves, likely originating from quantum vacuum fluctuations derived from an immanent zero-point energy (ZPE)/superfluid quantum space. Since the whole human organism, including brain is embedded in this dynamic energy field, a comprehensive model for human (self)-consciousness could be conceived. Evidence is presented for a pilot wave guided supervenience of brain function that may arise from a holofractal memory workspace, associated with, but not reducible to the brain, that operates as a scale-invariant mental attribute of reality. This, field-receptive, workspace integrates past and (anticipated) future events and may explain overall ultra-rapid brain responses as well as the origin of qualia. Information processing in the brain is shown to be largely facilitated by propagation of hydronium (proton/water) ions in aqueous compartments. The hydronium ions move freely within a hexagonally organized H<sub>2</sub>O lattice, providing a superconductive integral brain antenna for receiving solitonic wave information. A nonlinear Schrödinger equation describes the quantum aspects of the transfer of wave information mediated by H<sup>+</sup> and Ca<sup>2+</sup> ion flux over long distances at cerebrospinal, inter-neuronal and gap junction spaces. The latter processes enable ultra-rapid soliton/biophoton fluxes that may orchestrate overall brain binding and the creation of coherent conscious states. In a cosmological context, we envision a scale invariant information processing, operating through a toroidal/wormhole mediated information flux. Our concept touches upon the earlier postulated hard problem in consciousness studies. This implies an intrinsic cosmic connectivity that is mirrored in the human brain. The assumed hydrodynamic superfluid background field is proposed to guide the ongoing fabric of reality through a quantum metalanguage that is instrumental in the manifestation of universal consciousness of which human consciousness is an integral part.

## 1. Introduction: Science-Historical Background for the Present Work

At the time that Erwin Schrödinger published his book on “What is Life” in 1944, he was left with a question: what is the physical mechanism that provides the neg-entropic accumulation of life information in cells so that they can survive and reproduce. It lasted a few decades until Herbert Fröhlich postulated that the potential answer could lie in coherency of wave information, while Fritz-Albert Popp, following the work of Gurwitch (see **Belousov et al., 2004**), pioneered in researching a potential mechanism for ultra rapid intracellular communication in revealing a potential signaling system: the biophoton. If photons are involved, one speaks implicitly about electro-magnetism and the cell *electrome* (**De Loof, 2016**, see **Fig. 1**). Much later Stephen Hawking proclaimed: everything that matters in the universe is electro-magnetic field activity. The force field idea reached back to David Bohm who advocated the idea that our world is steered by pilot waves that emerge from a quantum fluctuating domain that cannot be observed: the implicate order that later was interpreted as the zero-point energy field or a superfluid quantum space.

It was the Nobel laureate **Wilczek, 2008**, who claimed that fabric of reality comes about by harmonic relations of discrete wave frequencies displaying beautiful patterns, among others reflected in the color spectrum. Sir Roger Penrose, 1998 went even deeper by claiming that consciousness in the brain arises from a sort of resonance of tubulin proteins to produce neuronal communication with vibratory ripples of the supposed smallest scale in the known universe: the Planck scale. Gravitational activity at this extreme micro-level would induce the recognition of basic information required for consciousness: the so-called qualia. Yet, knowledge on the discrete values of the crucial quantum wave frequencies at stake remained scattered, and it was a meta-analysis of biomedical literature, treated in the present paper, that revealed qualitative and quantitative properties.

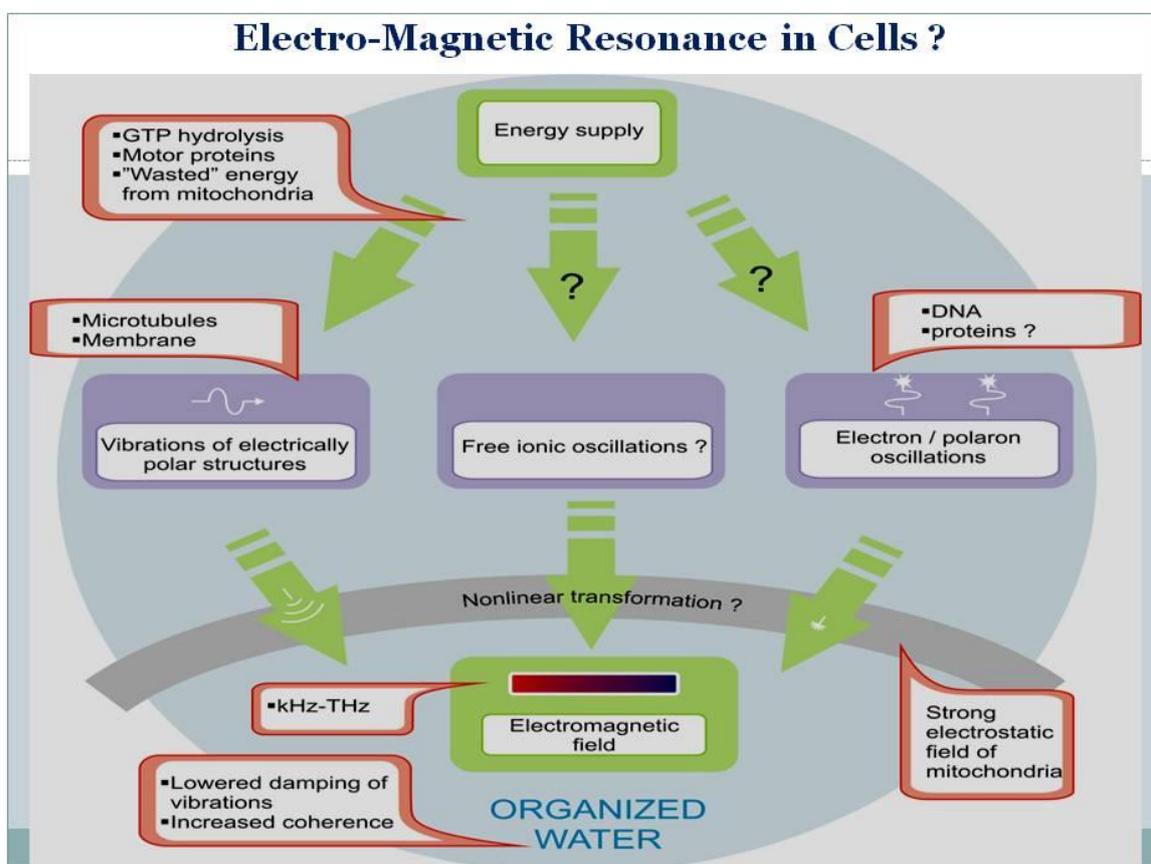
Scientific endeavor in general should be conceived as a product of our consciousness in which, in fact, a part of nature investigates another part in full detail. This aspect raised the crucial question: how can current science neglect the phenomenon of consciousness, being the very basis for performing science and write about it? (**Meijer, 2018**). Clearly, we should improve our insight in the mechanisms of this versatile information processing instrument, not only by penetrating into its biological nature but also taken into account its inherent cosmic connections. *In this review an attempt is made to integrate the various concepts of the authors in a comprehensive treatment of the physics of consciousness, realizing that life in the cosmos cannot exist without fine-tuned collective modality of information.*

## 2. Discovery of a Semi-harmonic EMF Background Field in Life Systems

A biophysical basis for spectrum of discrete electromagnetic field (EMF) frequencies, that were shown to affect health and disease, was elaborated and generalized (**Meijer and Geesink, 2016; 2016b, 2017 a, 2018 c**). The particular pattern of EMF frequencies fitted modern music theory that found an ancient basis in a 12-tone octave-like semi-harmonic structure, based on an adapted Pythagorean tuning. The grounding mathematics with real and imaginary numbers predicted a rotatory feature that introduced the idea of vortices and even toroidal geometries. The fractal nature of this life algorithm suggested a cosmic dimension producing longitudinal solitonic waves from black holes down to vortice-like energy distribution at the Planck scale, as a true meta-language of nature. A scale invariant toroidal operator, displaying a communicative wormhole structure emerged as a connective principle in the universe. The self-referential aspect of torus trajectories and knots pointed at a relation with the reflective states of human self-consciousness. The particular EMF pattern was revealed by us through a meta-analysis of more than 500 biomedical publications that reported life-sustaining as well as life-

threatening EMF frequencies. The particular semi-harmonic scale exhibits a core pattern of twelve eigenfrequency functions (**Fig. 2**), with adjacent self-similar patterns, according to octave hierarchy (**Geesink and Meijer, 2016a; 2016b, 2017a; Geesink and Meijer 2018b**).

It should be realized that this frequency pattern reflects experiments in which the life systems were exposed to *external* EMF radiations, but it is clear that life conditions are also influenced by the presence of *endogenous* EM frequencies. We postulated that this coherent pattern is effective because it mimics *internal* oscillations within the organism and its constituting cells, and acts through resonant communication, as extensively discussed in literature by many others (see **De Loof, 2016; Hammershlag et al., 2016; Muehsam and Ventura, 2014; Rouleau and Dotta, 2014**). Our studies should be seen in the light of the rapid expanding areas of Biofield Research, including that of Quantum Biology, as adequately reviewed by (**Huelga et al 2013; Lambert et al., 2013; Lloyd, 2011; Marais et al., 2018**).



**Figure 1:** EMF resonance in various organelles in the cell results from internal energy sources and/or external EMF radiation. Through coherence of wave information, a local EM fields may arise mediated by organized water domains in their different levels. (after **De Loof, 2016**)

### 2.1. The Mathematical Basis for a Generalized Music Algorithm

A more detailed mathematical analysis (**Geesink and Meijer, 2018a**) shows that the derived arithmetical scale exhibits a sequence of unique products of integer powers of 2, 3 and a factor  $\sqrt{2}$ . These discrete eigenfrequency values can be related to supposed bio-resonance of solitons or polaron

quasi-particles in life systems. Bio-solitons are conceived as self-reinforcing solitary waves, that constitute local fields, being involved in intracellular geometric ordering and patterning, as well as in intra- and intercellular signaling. The discrete pattern of EM wave frequencies is mathematically expressed as follows:

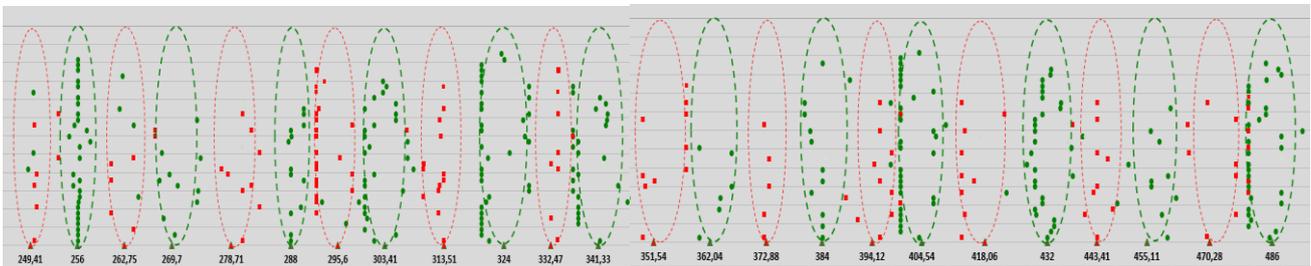
$$E_n = \hbar \omega_{\text{ref}} 2^n 3^m (2^p)$$

( $E_n$ : Energy distribution,  $\omega_{\text{ref}}$ : Reference frequency 1 Hz,  $\hbar$ : Reduced Planck's constant,

$n$ : Series of integers: 0, 0.5, 2, 4, 5, 7, 8, -1, -3, -4, -6, -7,

$m$ : series of integers: 0, 1, 2, 3, 4, 5, -1, -2, -3, -4, -5,

$p$ : Series of integers: <-4, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, > +52)



**Figure 2.** Measured frequency data of living cells systems that are life-sustaining (green points) and detrimental for life (in red squares) versus calculated normalized frequencies. Biological effects measured following exposures or endogenous effects of living cells in vitro and in vivo at frequencies in the bands of Hz, kHz, MHz, GHz, THz, PHz. Green triangles plotted on a logarithmic x-axis represent calculated life-sustaining frequencies; red triangles represent calculated life-destabilizing frequencies. Each point indicated in the graph is taken from published biological data and are a typical frequency for a biological experiment(s). For clarity, points are randomly distributed along the Y-axis.

The complete range of EM frequencies (lying between 0.2 Hz to 500 THz, see **(Geesink and Meijer, 2016)**), on basis of the 12 core frequencies, is depicted in **Fig. 2**. See for a statistical analysis and validation of the frequency pattern the recent paper of **Sonderkamp et al, 2019**. The entire fractal pattern can be easily calculated by expanding to lower and higher frequency ranges by multiplication or division by a factor 2. This provides an octave hierarchy of self-similar extensions of the scale. Multiplying this value with the octave hierarchy of 2, up to the THz-range ( $10^{12}$  Hz), a range can be found where the biophysics of ordering of water molecules, relevant for life conditions, is at stake **(Geesink and Meijer, 2019)**. It is of interest that the boundaries of the GM frequency spectrum, apart from IR and visible part of the spectrum, also lie in the far-infrared EM region, that occupies a middle ground between microwaves and infrared light waves, known as the “terahertz gap”. Tera-Hertz EMF frequencies take a special position in the frequencies of life **(Hand and Yates, 2017)**, as well as in treatment and detection of diseases **(Siegel, 2004)**. Interestingly, infrared frequencies have recently been related to long-range universal metric fluctuations near null surfaces in the entire cosmos. These scale-invariant spacetime fluctuations have a longitudinal character and, on the Planck level, may explain quantum gravity in a holographic context **(Verlinde and Zurek, 2019)**.

## 2.2. The Generalized Music (GM)-scale: a Novel Biophysical Principle Shown in Animate and Non-animate Systems

What can be concluded from the spectrum of data from our publications and related compatible literature data (see **Table 1**). First of all, it should be clear that these concepts are based on the notion that nature is quantized according to the principles of quantum mechanics. If we assume that also electromagnetic fields have a quantized character, it follows that EM frequencies can only occur at discrete eigenvalues: to be defined as standing waves at typical frequencies. Such standing waves are able to interact and can produce constructive interference patterns that have a discrete character composed of eigenvalues.

Subsequently, meta-analyses of literature were performed for EMF frequencies that influence cancer, promote entanglement in EPR studies, in addition to energy distribution of elementary particles of the Standard model, energy gaps in superconducting materials and recently in EMF absorption frequencies of pure water (see **Table 1**). Without exception, these studies demonstrated a striking fit with the revealed coherent GM-scale.

**Table 1: Guiding EMF GM- principle in Animate and Non-animate system**

<i><b>Animate systems</b></i>	<i><b>Non-animate systems</b></i>
- Biomedical research (1)	- Entanglement in EPR-experiments (6)
- Cancer research (2)	- Energy distribution elementary particles (7)
- Neurological studies *0	- Coherence behavior in superconductors (8)
- Albumin vibr. resonances *1	- Sound induced vibration patterns Chladni, *4
- RNA synthesis catalysis *2	- Phyllosilicate semi-conductor materials *5
- Brain function and Consciousness (3, 4)	- Zero- point energy EM frequencies *6
- Protein folding in intact cells (5)	- Gravitational waves *7
- Superconduction in life systems (8)	- EMF absorption Spectrum of pure Water (9)
- Oligo-nucleotides in solution *3	- Nucleotide sequence in DNA *8
- IR-spectra of proteins, lipids, DNA (10)	

\*= **EMF frequency. values extracted from related international literature.**

*In brackets (nr.): reference to own publications :(1) Geesink and Meijer, 2016; (2) Meijer and Geesink, 2017; (3) Meijer and Geesink, 2016; (4) Meijer and Geesink, 2018; (5) Meijer and Geesink, 2018; (6) Geesink and Meijer, 2018 a; (7) Geesink and Meijer, 2018b; (8) Geesink and Meijer, 2018 c; (9) Geesink and Meijer, 2019a; (10) Geesink and Meijer, 2019c.*

**Supporting research of others:** \*0: Hamblin et al, 2017; \*1: Nardeccia et al, 2017; \*2: Ferris, 2006; \*3: Tang et al, 2018; \*4: Chladni, 1980; \*5: Adamatzky, 2013/Hashizume, 2012; \*6: Irikura, 2007; \*7: Rezolla et al, 2003; \*8: Selvam, 2007

Additional literature search revealed very similar frequency patterns in the color spectrum, for wave resonances of phyllosilicates, albumin and nucleotides in aqueous solution, as well as for a candidate RNA-catalyst (see **Table 1**). This indicated that physical systems that deal with quantized electromagnetic aspects, based on standing waves and constructive wave interference, may show such a discrete pattern of EM frequencies.

The collective evidence, presented above, indicates that discrete quantum coherence, entanglement and superconductivity may not only be prerequisites for life, but that similar frequency patterns may operate also in non-animated physical materials.

Superconductor features of life were proposed by **Cope** as early as in **1975** and have been demonstrated in current quantum biology: in olfaction, long distance magnetic navigation of various animal species and in particular in photosynthesis (reviewed by **Huelga et al, 2013; Lambert et al, 2013; Lloyd, 2017; Marais, 2018**). It should be realized here that life material is build up from elementary particles and that essential macromolecules such as proteins and DNA have an inherent vibrational property that can show coherent features. In cells, this is likely to be supported by coherent domains of structured layers of water (**Melkikh and Meijer, 2018; Geesink and Meijer, 2019a and b; Bischof and Del Giudice, 2013; Pang et al, 2016; Preto, 2016**). The latter aspect was suggested by us also be instrumental on the process of 3D- folding of proteins to their functional structure (**Meijer and Geesink, 2018**), as supported by many other studies reviewed in (**De Loof, 2016; Hammerschlag et al,2015; Muehsam and Ventura, 2014; Rouleau and Dotta, 2014; Bischof and Del Giudice, 2013; Pang et al, 2016; Preto, 2016 ; Brizhik, 2014; Fröhlich and Mc Cormick, 2013**).

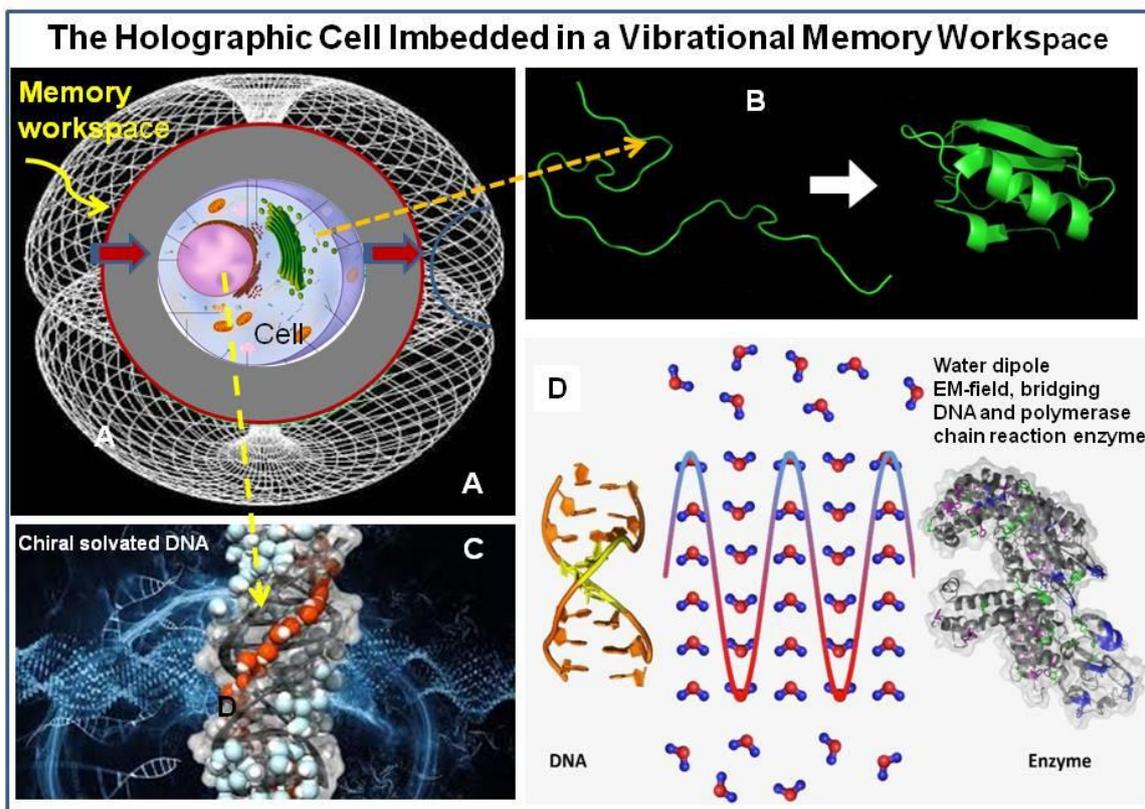
The Fröhlich/Davydov concept (**Bischof and Del Giudice, 2013; Pang et al 2016; Preto,2016; Jerman, 2016**) on soliton influence on protein vibration has been elaborated and further improved by (**Pang et al, 2016**), taking into account that solitons can be largely stabilized, and their life-time increased due to mutual interaction of the particles with lattice vibrations. The important point here is that the soliton transport should be regarded as a concerted action of both the vibration of the quasi-particle and that of the protein backbone lattice in interaction.

Finally, we want to stress that dynamics of the biophysical processes at stake (harmonics/music, entanglement, superconductor conditions and elementary particles (knot theory), all can be modeled by toroidal geometry, as shown by us in the related studies. We consider the torus as a versatile space-time operator for the handling and integration of information (energy) fluxes, in which the physical information is projected in a holographic manner in a 3-D/4-D context and the syntropic life information is projected in a scattering event horizon (**Kirillov, 2012**). Such field-sensitive toroidal workspaces have been postulated as a key element for the creation of scale invariant consciousness in the universe (**Meijer and Geesink, 2017**). We propose that an implicate order, as proposed by David Bohm, finds its physical expression in an information/geometric domain described either as a superfluid crystal-like matrix, or as zero-point energy fluctuations. The latter processes could well be related to the concept of “quantum foam” at the level of the Planck scale or even beyond this domain (see later **Fig.13**). Our studies may contribute to a better understanding of supposed bio-fields in the evolutionary organization of complexity. Such guiding processes (**see section 7**) may have operated on the brink of inanimate and animate structures in biological evolution and, in our opinion, are still instrumental in the ongoing fabric of human and cosmic consciousness.

### **2.3 EMF Guided Model for 3-D Functional Protein Folding in Integrate Cells**

Recently, the potential long-range resonant influence was further worked out in a study of 3-dimensional protein folding in the intact cell (**Meijer and Geesink, 2018**). This process can be largely influenced by the formation of coherent oscillation domains in the cell water interacting with the protein backbone (**Fig. 3**). We argued in earlier work that the current geometric and thermodynamic approaches in protein folding studies do not provide a definite solution to understanding mechanisms

of folding of biological proteins. A major problem in the understanding of this process is that the protein is first synthesized as a linear molecule that subsequently must reach its native configuration in less than 1 sec (**Melkikh and Meijer, 2018**).



**Figure 3:** The life cell in a toroidal setting showing a holographic memory workspace called event horizon, that contains information for cell function and survival in the particular environment (A, upper inset left), guiding 3-D protein folding (B), wave resonance of DNA with associated water (C). Structured water-dipoles in coherent state provide an information imprint that stably stores DNA-polymerase chain reaction activity (after **Montagnier et al, 2017**)

Hydrophobicity-hydrophilicity models and random search mechanism cannot explain folding to the 3-D functional form, as it occurs in the intact cell. We propose an integral approach, based on the embedding of proteins in the whole cellular context under the postulate: a life protein is never alone (**Meijer and Geesink 2018; Melkikh and Meijer, 2018**). In this concept the protein molecule is influenced by various long and short distance force fields of nature such as, gravity, dark energy anti-gravity and electromagnetic pilot waves from zero-point energy field. This process is pictured as being influenced by long-distance polaron/soliton vibration patterns as well as by holographic memory of integrated cell function (see also **Mitchell and Staritz, 2011**) that, according to our concept, is build up for any individual cell. This approach to protein folding differs from usual quite artificial ones, in that it takes into account many of the local cellular conditions in a more holistic frame work. Recently **Qin et al, 2019**, interestingly, showed that protein structure can be converted into audible sound and reversing the process and including variations in the derived musical passages on a 20-tone musical scale can in principle convert it back to an entirely new protein, supporting our music guided protein folding concept even in a broader context. Similar long-distance guiding effects and resonances may also be true for DNA, that have been shown to exhibit distinct EMF vibrations by oscillations of

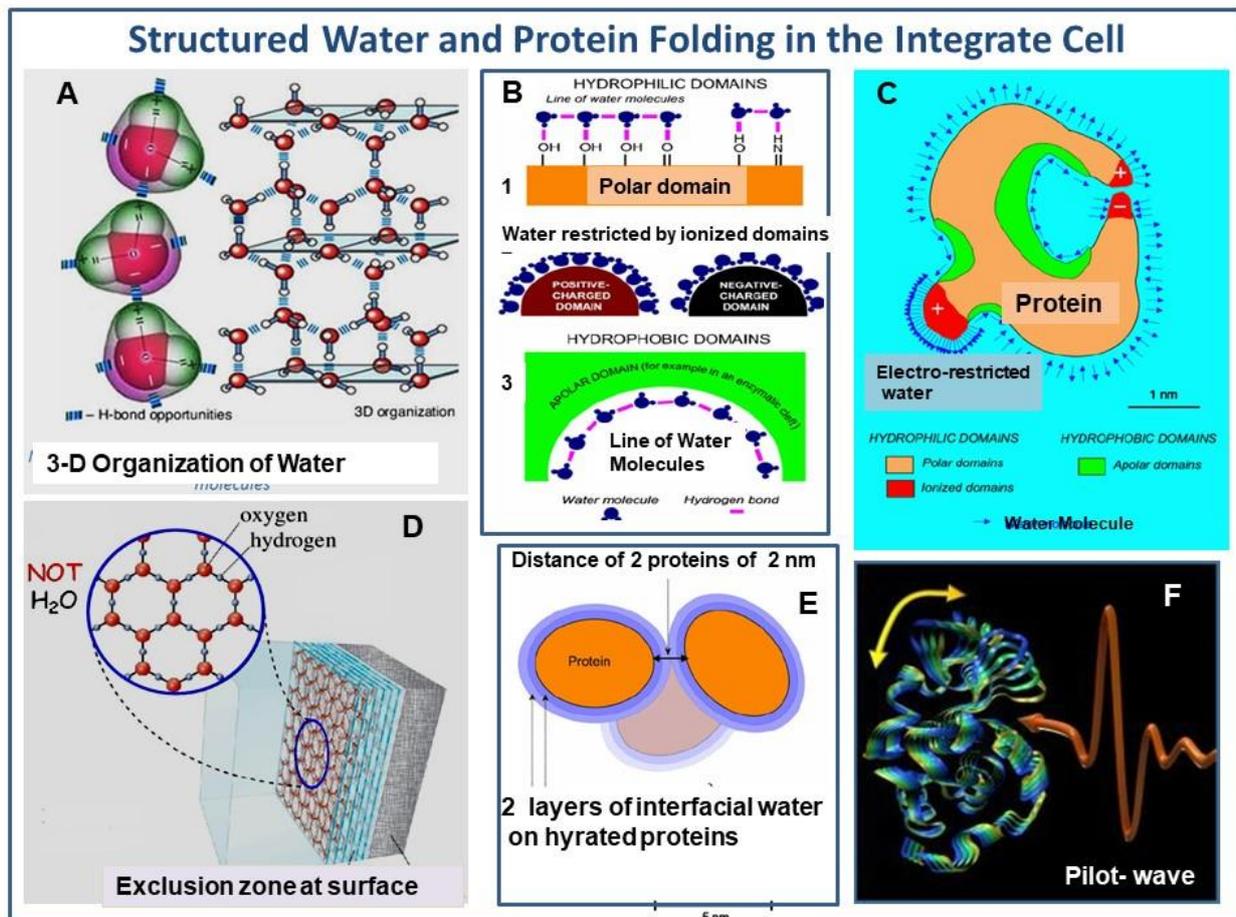
delocalized pi-electron clouds and protons of base stacks, this in concerted action with associated structured water and microtubular information transmitters, rendering it a universal resonator in brain (**Savelyev et al, 2019**). It is also of interest that in this respect **Wong et al., 2019**, propose a 5-D model for creating of life forms on the basis of p-electron induced HT conductivity of membrane associated macromolecules on the surface of cells, producing information patterns that may match those of DNA and therefore may reflect the holographic cell memory hypothesis implied in our studies (**Meijer and Geesink, 2018**).

## **2.4 Potential Spiral/Toroidal and Periodic Character of Wave/Particles in Space-time**

Elementary cycles theory (ECT) of (**Dolce, 2017**), postulates that every elementary “particle” of nature is characterized by persistent intrinsic space-time periodicity. In ECT the Planck energy spectrum is interpreted as a harmonic like spectrum of a mass-less periodic modalities of fundamental time periodicity  $T$  (quantized energy:  $E_n = n\hbar\omega = n\hbar/T$ , discretized angular frequencies:  $n\omega$ , and time periodicity  $T = \hbar/E$ ). According to ‘t Hooft (**t’Hooft, 2007, 2016**), it is assumed that a theory describing our world starts with postulating the existence of sub-systems that, in a first approximation, evolve independently, and then are assumed to interact. It is suspected that our world can be understood by starting from a pre-quantized classical or “ontological” system. If time can be assumed to be discrete, the Hamiltonian eigenvalues would turn out to be periodic. Both theories favor a quasi-classical and quantum ontological interpretation of quantum physics, as in a primary form earlier suggested by David Bohm (**Bohm and Hiley, 1983, Bohm and Peat 2008**) as discussed by us in (**Geesink and Meijer, 2018b, Geesink and Meijer, 2018c**).

Solitons/polarons, as quasi particles, are a widely observed physical phenomena that behave like solitary waves but possess many features of particles. They are able to suppress anharmonicity (the deviation of a system from being a harmonic oscillator) by the excitation to higher quantum levels, a process that facilitates the crossing of potential barriers and the transfer of a molecule to a new conformational state (**Geesink and Meijer, 2017; Meijer and Melkikh, 2018; Meijer and Geesink, 2018a**). When particles within fields move around following classical laws, then these classical laws could resemble classical field theories such as the Navier-Stokes equations and the existence of vortex and toroidal solutions (**Fremling et al, 2013; Zagosking et al 2015**), see also **section 7**.

Also, high-frequency quasi-periodic oscillations measured in a torus orbiting in the vicinity of a black hole probably obey to the abovementioned Eigenfrequencies of the proposed GM-algorithm. According to Rezzolla (**Rezzolla et al, 2003**), the torus, in fact, can be thought of as a cavity in which the p-modes effectively behave as trapped sound waves. If the sound speed in the cavity were constant, the frequencies of these standing waves would be in an exact integer ratio. In reality the sound speed is not constant but the Eigenfrequencies found are in a sequence very close to 1:2 and 3:4. So cyclic energy trajectories and periodicity in quantum physics may be envisioned as coherent resonances of atomic cascade transitions of materials. Potentially, these informational frequencies are linked with the ZPE/SFQS field, through resonances leading to phase-locked cellular information attractors (**Keppler, 2012, Sbitnev, 2016**), that are functionally separated by non-coherent wave activity (**Meijer and Geesink, 2017**). The latter could explain the function of interwoven “coherent” and “non-coherent” EM/quantum values and the presence of trajectories corresponding with initial vibrational energies of molecules and atoms equal to their measured vibrational zero-point energy (**Fremling, 2013, Irikura, 2007, Sbitnev, 2016**).



**Figure 4:** Hexagonal oriented assemblies of dipole water molecules (A and D), structured interfacial waterlayers at protein molecular surfaces (exclusion zones) as influenced by relative hydrophobic and hydrophilic domains (B, C, E) leading to hydrated proteins that can undergo resonant vibrations through internal and external EMF field activities (F)

## 2.5 The Implications of the GM- scale- EMF Frequencies for Superconductive conditions in animate and non-animate systems

Our meta-analysis of the data of different superconductors gaps/frequencies from 1981 to 2018 (Geesink and Meijer, 2019a) revealed that the reported values can be positioned on GM- pointer states and fit with the derived equation of coherent frequencies: an adapted Pythagorean scale. The discrete values of these frequencies, thus, could again be positioned on a reference coherent THz-scale, that is expressed in twelve discrete coherent reference THz-frequencies:

1.0995, 1.1583, 1.2370, 1.3031, 1.3915, 1.4660, 1.5549, 1.6493, 1.7376, 1.8554, 1.9547, 2.0873 Thz

As pointed out in our earlier studies (Meijer and Geesink 2016; Meijer and Geesink, 2018c), both lattice and wave conditions are envisioned in a fractal structure of life systems, being much in line with recent proposals of Turner and Nottale (2019). It is envisioned that the result of these processes will finally exhibit a prominent coherent high temperature conductor (HTSC)-system, fully guided by coherent wave domains, that can be described by toroidal geometry and numerically expressed by the GM-scale frequency pattern. This implies that phonon- or photon lasing with the proper combination of coherent wave frequencies, decoherence could be suppressed, leading to stable

pointer states. As an alternative, apart from this dominant influence of coherency in HTC superconductivity, some extent of decoherency may play a decisive role either by matrix disturbances (vibrations) that may facilitate the overall rate of charge transfer, as have been suggested in recent studies on photosynthesis. This aspect was also attributed to fractal disordered selection of coherent spin states as suggested by **Turner and Notale 2016, 2019**, while also the adding of general noise may promote the formation of polaron and polariton quasi-particles that, as mentioned before can be instrumental in Cooper-pair electron formation.

**Turner and Notale, (2016, 2019)** reported on recent theoretical developments, which suggest that a set of shared principles underpin macroscopic quantum phenomena observed both in high temperature superconducting materials, room temperature coherence in photosynthetic processes and the emergence of long-range order in biological structures. These systems are driven by dissipative systems, which lead to fractal assembly and a fractal network of charges (with associated quantum potentials) at the molecular scale. At critical levels of charge density and fractal dimension, individual quantum potentials may merge to form a ‘charged-induced’ macroscopic quantum potential, which act as a structuring force dictating long range order. Whilst the system is only partially coherent within these processes, many of the phenomena associated with standard quantum theory are recovered, with macroscopic quantum potentials and associated forces having their equivalence in standard quantum mechanics.

The overall picture is that superconductor materials can be seen as a multi-cavity network on which an energy valley of electromagnetics is superposed that produces 3-D resonance chains of EM activity, yet contain characteristic energy gaps. This reminded us of the work of **Hunt, 2019** on consciousness and brain function, postulating that *EMF resonance chains* may explain the certain aspects of consciousness. Such a type of superconductivity may indeed play a role in information processing in the brain as also proposed in the work of **Bandyopadhyay** (see interview with him by **Tam Hunt, 2017**, see also **section 5.10**) as well as the superconduction-inducing properties of hydrated protons in aqueous brain compartments as proposed by us (**section 7**).

Turner and Notale established a hypothesis that the development of structures analogous to those found in biological systems, should also lead to increased critical temperatures in HTC- materials, very much supporting our view on similarities between discrete frequency patterns in both superconductors and life systems as found in our recent study (**Geesink and Meijer, 2019a**). We proposed therefore, to apply semi conductive smectites (phyllosilicates), studied in detail by us earlier (see **section 6.2**), that radiate GM-like EMF frequencies, in combination with HTC-superconductor materials, to further improve superconductive properties as a modality of intrinsic quantum lasing. The knowledge of the revealed series of discrete frequency bands in superconductor materials, realizing the currently developed laser technologies that cover the entire EMF-spectrum, as well as the striking excitation/radiation semi-conductive features of smectites, could be applied to attain superconductive modes that finally may reach significant higher operation temperature levels. Our observations on these discrete energy gaps in presently available superconductor materials, highlight a potential quantum bridge between superconducting properties in physics and biology. This also focuses attention on the fact that any material superconductor is permanently embedded in a zero-point energy field. Consequently, the intrinsic vibratory character of such fields should be taken into account as was realized in a number of previous papers on holographic aspects of superconductivity (references in **Geesink and Meijer, 2019a**).

### 3.1 EMF Frequencies of Water Reflect Coherent Quantum Information of the GM-scale

Water is quantum coherent under ordinary conditions, according to a quantum electrodynamics field theory that may explain many of its most paradoxical properties including life itself (**Vitiello, 2001; Jibu and Yasue, 1995; Umezawa, 1993**). Quantum fluctuations and coupling between matter and electromagnetic field in Quantum Electro Dynamics (QED), predicts quantum coherence for liquid water even under ordinary temperatures and pressures, according to **Del Giudice, (2009, 2010)**. This theory suggests that interaction between the vacuum electromagnetic field and liquid water induces the formation of large, stable coherent domains (CDs) of about 100 nm in diameter at ambient conditions, and these CDs may be responsible for all the special properties of water including life itself (**Fig. 4**).

Nowadays, it is expected in the biological community that life originated in water and that the multitude of organisms found their habitat in it. Water provides the medium in which all biochemical reactions take place. The importance of water to living organisms originates from its peculiar features including the solvent properties, its high specific heat capacity, as well as its high latent heat of vaporization. Water owes these unique properties to the polarity (dipole character) of its constituent molecules and in particular to the ability to form hydrogen bonds internally and with other molecules. In this view, water is seen as an active medium where the principle of coherent information starts from inanimate liquid systems up to highly organized organisms (**Jerman, 2016**). Namely, contemporary quantum field theory does not only unveil life as a profoundly electromagnetic phenomenon, it maintains that all liquids including water have special electromagnetic properties involving coherence.

Consequently, the organizing potential of water bound to countless biochemical as well as biophysical processes is proposed to play an active and essential role, not only living systems as known nowadays, but also any feasible origin of life scenario. In QED the theorem can be proven (see (**Plankar et al., 2012; Jerman 2016**) for more detail), according to which all molecules fluctuate in unison between two individual configurations, in tune with the enveloping vacuum electromagnetic field. The collective dynamics spans over a region (Coherence Domain, CD) whose size is the wavelength  $\lambda = hc/\Delta E$  of the EM mode, whose frequency in the free space is  $\nu = \Delta E/h$ ;  $h$  is the Planck constant and  $c$  is the speed of light. Further QED considerations demonstrate that within the CD photons acquire an imaginary mass so that they are unable to propagate themselves and rather appear as the cohesion energy of the molecules. The CD thus becomes a self-produced cavity for the vacuum electromagnetic field, which fuses with the matter field of an ensemble of excitable molecules, hence giving rise to a unique field describing the collective dynamics of the molecules that behave as a single (quantum like) object.

Stability of the coherent configuration is kept by its lower energy level, namely by the existence of an *energy gap*, the difference in energy between an independent (non-coherent) and correlated (coherent) molecular configuration. This means that the coherent state is a stable (low energy) and at the same time ordered state, having low entropy; thus, *no energy is required for the maintenance of order* (**Vitiello, 2001**). In this stabilized order, quantum vacuum field is essential. At any given temperature that allows liquid water there is some proportion of water molecules in coherent domains and another in the non-coherent ones; at room temperature a molecule of water spends around 30% of time in a coherent domain (**Yinnon & Elia, 2013**).

Quantum electrodynamics further predicts a picture of living matter, which clearly accounts for a decisive role of water. Biological polymers present in the interstices between CDs are subjected to the tails of the coherent EM (evanescent) fields, protruding from the CDs. According to general theorem of electrodynamics, molecules able to oscillate at the same frequency of the CD field are strongly attracted and therefore able to react chemically (**Del Giudice et al., 2005, Del Giudice et al., 2010**). Hence,

in an extended coherent region a diffusive regime of molecules is replaced by a selective dynamic regime, where molecules recognize and interact on the basis of frequency codes. Biological dynamics appears therefore as a close interplay between electromagnetism and chemistry, where fields are able to make the molecules interact through resonance, and molecules are able to regulate the field frequency through their reaction energies.

Hydrophilic surfaces could extend their influence over distances from the interface much larger than one or two layers as proposed in conventional physics (**Zheng, 2006**), and forms an ‘exclusion zone (**Fig. 4**), where solutes are excluded, next to a hydrophilic surface, up to hundreds of microns thick, that is stable if undisturbed, once it is formed (**Chai, 2008; Zhao, 2008, Pollack 2013**). Furthermore, it has been proposed that the solute-free zone is a physically distinct and less mobile phase of water that can co-exist indefinitely with the contiguous solute-containing phase and the width of the solute-free zone is typically several hundred microns (**Zheng, 2006, 2009**). It has also specific electrical properties, having an excess of negative ions/electrons vs. bulk water, the latter with the dominating positive charge. It has also an alkaline pH (pers. communication).

According to the general scheme outlined above, water molecules in bulk are predicted to give rise to CDs having size around  $0.1 \mu$  (**Arani et al., 1995**). In biological environments, however, these CDs are presumed to give rise to extended – higher order – domains constrained by the particular level and excited by the metabolic energy flow, they may extend to the size of molecular complexes, or even a whole cell or tissue (**Del Giudice and Tedeschi, 2009**). Since the excitable spectrum of a CD is very rich, a variety of extended (higher level) domains can emerge that may assume fractal (nested) architecture, as analyzed by **Vitiello**] and as in harmony with the theory of GM scale physical principle (**Geesink and Meijer, 2017a, 2018a**).

Extended domains (**Del Giudice and Tedeschi, 2009**), also called superdomains, imply two important consequences, namely a defined size of the coherent system, and the appearance of *geometrical shapes*. In order to have precise frequency matching, the relative positions of reacting molecules must assume a specific spatial configuration, corresponding to biological structures. When the coherence is switched off, geometrical order would break down; the system’s size would no longer be defined, as it is primarily determined by the wavelength of an EM mode. Coherence and entanglement may be regarded as fundamental properties of quantum domains, be them basic or extended. Their coherent oscillations represent stationary waves (i.e. temporally and spatially constant) that enable types of wave interference, known as constructive. Quantum coherence with sufficient lifetime is thus preserved in living cells at room temperature.

The crucial question that remains is how water in the cell, i.e. cytoplasm, will behave in the presence of many types of macromolecules, inorganic and organic ions, etc. The solution for this is likely not to collect individual frequencies of various isolated proteins, DNA/RNA strands, channel proteins, tubulin proteins, etc. because those values depend on the composition of environment in which the particular spectroscopic measurements have been performed. Rather, the entire integral cell should be taken into consideration, including cytoplasm, organelles, plasma membrane, etc. (See **Meijer and Geesink, 2018b**)

### **3.2 ZPE-Field Effects and the Organization of Water molecules in Life Conditions**

Quantum field theory explicitly recognizes an extended quantum vacuum field, (“zero-point field or superfluid quantum space”), interacting with matter, as well as quantum fluctuations, whereby energy

in the vacuum field in the form of photons can be captured by matter. When energy is absorbed from the vacuum field, the particles will begin to oscillate between two configurations. In particular, all particles coupled to the same wave-length of the fluctuations will oscillate in phase with the EM field, that is, they will be coherent with the EM field. According to calculations performed by **Preparata and Del Giudice, (1992)** and colleagues, the renormalized (physically observable) frequency of the trapped EMF in the CD corresponding to 0.26 eV is  $6.24 \times 10^{13}$  Hz, which is in the far infrared region. Del Giudice *et al.*, also argued that water CDs can be easily excited, and are able to collect small external excitations to produce single coherent vortices whose energy is the sum of all the small excitation energies, turning the originally high entropy energy into low entropy coherent energy, which is trapped stably in the water CDs.

It stands to reason that if cell water is exposed to an EM field in the form of quantum states in the frequencies detected by us, it will lead to a “geometric imprinting” that resembles the above mentioned geometric Chladni patterns at a much smaller scale and thereby exerts a coherent ordering of cell plasma, including the associated macromolecules. Similar, GM-like discrete EMF, effects were recently reported by **Sheldrake and Sheldrake, (2019)**, inducing superficial geometric (Faraday) patterns in water. It is of interest that a new quantum state of water molecules was discovered with a 6-fold rotational symmetry (**Fig. 4**), in which the water dipole molecules are arranged in a kind of superposition, that is, if they are placed in tiny channels in tiny spaces of the type that also occur in living cells. (**Johnson, 2009; Kolesnikov, 2016**). The particular water clusters possess unique terahertz frequency vibrational modes in the 1-6 THz range and are supposed instrumental in cellular architecture, protein folding, structuring of DNA/RNA, in addition to EM phonon coupling and specific absorption of gravitational active virtual photons from vacuum fluctuations. Of note, in an astrophysical context, the *structured water in cosmic dust* may contribute to cosmic background radiation and is candidate for baryonic dark matter (**Johnson, 2009, 2019**). This is important for life since water is seen as a fundamental substance for organizing biochemical processes (**Jerman, 2016; Bishof and Del Giudice, 2013; Arani et al., 1995; Del Giudice et al., 2005, Del Giudice et al., 2010, Carniello et al, 2015**).

Energy is constantly produced in the cell and this energy is partly converted into vibrations of all cell components, in principle, in the lowest energetic state possible (**Fröhlich, 1968**). However, as mentioned above, the cell is also influenced by ZPE quantum fluctuations, of which the discrete GM-frequency values that we revealed are a part of the total ZPE spectrum. This field activity can in principle excite all cell components by resonance. As treated earlier, long distance soliton directed influence in protein folding as described by us is an example of this (**Meijer and Geesink, 2018b, Melkikh and Meijer, 2018**). There is recent evidence that quantum zero-point fluctuations of a discrete wave frequency character can be experimentally observed and are clearly manifest in mesotropic structure in water (**Irikura et al, 2007, Ganeshan et a, 2013, Sen et al, 2015, Sen and Gupta, 2017**). The ZPE field acts on all mesoscopic surface water layers to form coherent phases of water with domains of the length of 100-300 nm and also may influence interfacial layers on macromolecules such as proteins and DNA. Such an effect was modeled by **Sen et al., 2015, 2017**. In relation to such processes in chemistry in general, it is quite relevant to mention the zero-point NMR study of **Thayer and Pines, 2019**, that revealed four zero-point frequency regions with peaks at 35, 111 and 132 KHz, that almost exactly fit our GM-scale values.

The crucial question is how to strike a balance between *internal* (endogenous) and *external* energetic EMF influences. **Turner, (2016, 2019 and personal communication)**, suggested that all molecules in the cell drive the cell water to certain vibrations, but in our opinion, it may be rather a symmetrical (bidirectional) process with mutual aspects. In other words, water is functioning as the primary antenna (mirror) of external EMF influences and is able to transmit those vibrations to other

dissolved substances in such a way that, in unison, coherent vibration domains of cell compartments are formed. The EMF frequency spectrum in pure water, as revealed in our recent paper (**Geesink, Jerman and Meijer, 2019, in press**), should be seen as the basic electrome energy landscape (**Fig.1**), on which, in the cell, the individual oscillations of macromolecules are superposed. Each individual cell component therefore, in principle, exhibits its own specific vibrational state, depending on molecular mass and aminoacid sequence and composition, molecular distribution of charges, internal hydrophobic interactions, final 3-D folding etc. Within the cell, the spatial conformation is also stabilized by interactions with hydrated ions and the structured (ZPE in-formed) water landscape. If wave resonance among such macromolecules is attained, phase-locked quantum coherent domains of various sizes in the cell are created. Such units of shared wave frequencies can also be promoted by interaction with the coherent EMF GM- photon frequencies and disturbed by the decoherent ones (**see Fig. 2**). In the material state, such photons are rather converted to phonons (matrix fibrations) that in turn can cover electrons and protons to form quasi particles such as polarons (solitons). The latter can travel along the protein backbone and at sites crucial for internal binding can perturbate the overall folding of the macromolecule.

The collective cell oscillatory matrix is in turn physically long-distance connected with other parts of the organism through quantum superposition and entanglement. This conductive aspect may also enable permanent pattern imprinting of molecular vibration in the water-layer structure and therefore can also explain the memory aspect of activated water that have been recently shown in two separate reports (**Montagnier et al., 2017; Magar et al., 2018, see Fig.3**). Spectroscopic measurement of oscillation frequencies of individual proteins in aqueous solution therefore can both show GM-scale *coherent* frequency values and *de-coherent* values, depending on the overall vibrational state of the multiple molecules dissolved. Of note, it has been postulated that the balance of coherent and decoherent states may be more dynamic than earlier thought and that creation of a coherent or decoherent state could in principle be a reversible process (**Vattay and Kauffman, 2015; Kauffman 2008, 2009; Bouchard et al, 2015; Chin et al.,2013**). Consequently, it would be justified to think in terms of dynamic states of coherence/decoherence in a cycling mode (**Kauffman, 2008, 2009**). Life would thereby always operate at the edge of chaos in a, so called, poised realm that allows the choice between two states in equilibrium thereby enabling fast responses essential for the cell ecology and survival, as reviewed by **Maldonado, (2018)**. Clearly, the position of this poised equilibrium state may undergo influence by intrinsic ZPE energy steering. We have earlier speculated that the presence of both *coherent* and *decoherent* wave frequencies in the life systems could reflect a potential regulatory mechanism. Alternatively, decoherent wave values could be related to removal of corrupted cells from the organism by, for instance, the crucial process of cell apoptosis (**Geesink and Meijer, 2017; 2018a**).

It is of interest that many of the discrete frequencies that influence life molecules are situated in the infrared/far-infrared EMF region (**Fröhlich, 1968; Hand and Yates, 2017**), that are also employed in therapeutic Tera-Hertz technologies (**Siegel, 2004**). Tera-Hertz ranges have also been implicated in scale-invariant quantum fluctuations (**Verlinde and Zurek, 2019**) that could arise from interferences of dual gravity and dark-energy fields in a wormhole connective context. We have earlier discussed consciousness in relation to toroidal geometric features of the universe, modelled as a Black Hole/White Hole structure with converging and diverging aspects, (**Meijer and Geesink, 2017**).

**Conclusion:** The cell and its components are always under the influence of active wave fields of internally ATP induced EM oscillations and are at the same time driven in concert by pilot waves of the quantum vacuum or implicate order (the Broglie/Bohm concept). Pilot-wave mechanisms have now

also been convincingly demonstrated in hydrodynamic experiments (**Bush, 2016**). As mentioned above, water may therefore also play a general role as a *cosmological conduit* since it is present in cosmic dust in the form of metal-doped phyllo-silicates that pervade galactic spaces in the universe. (see also **Carniello et al, 2015; Brown, 2019**). Biological systems exhibit macroscopic quantum properties, and superconductive properties (**Turner, 2016, 2019; Geesink and Meijer, 2018e**). The particular spectral patterns of water, that show multiple discrete absorption bands arise from the NIR and the mid-infrared region and perfectly fit the GM-scale frequency pattern (**Geesink, Jerman and Meijer, 2019**). Possibly, this knowledge can be applied for defining appropriate biomarkers for diagnosis of healthy and diseased states, which is researched in aquaphotomics (**Tsenkova, 2018**).

#### **4. Torus Operators Mediate Information Flux in a Super-Fluid Quantum Space by forming a Wormhole Communication Network**

Some of our previous publications present an array of physical modalities that are likely to be expressed in life systems: scale invariance/fractality, toroidal geometry, coherence/decoherence, entanglement as well as superconductivity and zero-point energy field as a supposed pilot wave domain. Yet, this spectrum of elements can be seen as clearly connected through the assumption of an underlying *informational background field* (**Meijer, 2012, 2014, 2015**). The latter can be envisioned as an energy/ information flux according to the geometry of nested tori, since the torus with its central channel in fact displays a sort of wormhole structure (**Fig.5**). **Haramain et al., 2016** and **Carr, 2017**, postulated an entangled torus/wormhole web, providing a fundamental connective matrix that is underlying the fabric of reality. **Meijer and Geesink, 2016, 2018**, postulated that such a background field may bear an electro-magnetic signature, exhibiting semi-harmonic like features. Interestingly, **Carr, (2017)** pointed at a potential link between micro- and macro-physics on the basis of quantum blackhole structures that may span the macro-mass range of cosmic blackholes up to the micro Planck scale and even beyond that level (**see also section 7**).

Of note, it has been shown that elementary particles can be modeled by toroidal geometry (**Williamson, 1997**). The idea of a torus/wormhole information matrix is supported by the work of **Susskind and Maldacena, (2016); Baez and Vicary, 2014; and Haramain et al., 2016**, who independently postulated that both the entities of space and time can be fundamentally described assuming that entangled particles are connected by wormholes (Einstein-Rosen bridges), in the so called ER=EPR framework (see for the time aspect of this concept also **Moreva et al., 2013**). Interestingly, it has been suggested that even matter/antimatter wave-particles are connected through a wormhole-like structure (**Jensen and Karch, 2013**). The latter was pictured as a string modality in a 3D setting that is holographically projected from a wormhole entity situated in a realm with 4 D-spatial dimensions. This type of connectivity may be manifest from the Planck scale up to elementary particles, molecules and life cells, and even can be expanded to the structure of our planet, galactic systems and finally the circular (rebound) character of the whole universe (**Meijer, 2012, Fig.6**).

A very similar construction, with a fractal character, is likely to be present in biological systems including the extremely complex and dynamic information workspaces of the human brain. In this respect, we hold that apart from the classical neuronal transmission system, an additional information guiding principle of quasi-particles such as polarons (solitons) and bio-photons is required to explain the super-fast brain responses and the phenomenon of (self)-consciousness (**Meijer, 2014; Meijer and Geesink, 2017**). The superconductive type of propagation of bio-photons in cell structures such as plasma-membranes, mitochondria, microtubuli, and coils of DNA, that all are associated with structured water layers, (**Bischof and Del Giudice, 2013; Preto, 2016; Jerman, 2016**), may therefore be instrumental in the synchronization of oscillatory neuronal networks in the brain (**Meijer**

**and Geesink, 2016, 2017**). Superconduction properties have also been described recently in warm and wet conditions in the field of quantum biology, for instance in quantum mediated processes in olfaction, magnetic navigation of animals and, in particular, in photosynthesis (**Marais, 2018**).

It is of interest that toroidal wormholes may support electromagnetic and magnetic flux (**Zagosking et al, 2015; Haramain et al., 2016; Jensen and Karch, 2013**), and the same time can scatter electromagnetic waves (**Kirillov and Savelov, 2012; Marquet, 2012**). This latter aspect was also proposed for superluminal photon flux in neuronal micro-tubuli, (**Musha and Caligiuri, 2015**). We speculate that the coherent set of discrete EMF frequencies revealed by us, is instrumental in creation of such super-radiance conditions. This idea is supported by the findings that a similar pattern of EMF frequency bands promote the creation of entangled conditions (**Geesink and Meijer, 2018 b**), is instrumental in the production of superconductivity (**Geesink and Meijer, 2019a**), as well as shows an almost perfect fit with the pattern of energy distribution of elementary particles (**Geesink and Meijer, 2018 c**, see **Table 1**)

One essential understanding here is that nature inherently includes information feedback loops in such systems that enable a “self-reflective” process in which the system learns from its environment, adjusts accordingly to maintain balance and well-being for itself, and communicates these data back to its environment, creating new patterns and behaviors that registers these adjustments and in turn again informs the living system as a whole (see further in **section 6**). We hold that the recurrent process that underlies this process can be modelled by toroidal geometry (**Fig. 5**). This geometric process of spiral *information enfolding and unfolding* can be literally observed and discerned conceptually in all natural systems, in metabolic processes, in the function of certain blood cells, as well as in the the resource exchange of plants and animals within their environment. It is also evident outwardly in the macrocosmic realms of planets, stars and galaxies, and inwardly in the micro-cosmic elemental and atomic realms (**Fig. 6**). Thus, the synergetics of torus geometry and recurrent toroidal energy flow patterns seems to be fundamental to all cosmic creation (**Lefferts, 2019**).

## **5. Brain Function and Consciousness Studies Modeled as a Holofractal Flux of Information with Toroidal Geometry**

### **5.1 Introduction.**

Consciousness, in a cosmological context, can be defined, as a state of a semi-stable system that has developed in a cooperative and cyclic operating mode, so that it became “causally self-observant”. According to **Dehaene, (2017)**, individual human consciousness can be envisioned as the processing of information that not only makes meaningful information available for global broadcasting in the brain, but also offers self-monitoring and quality control. Thereby, it cannot only predict aspects of the local environment, but also can integrate memorized information and future-directed projections into a personal worldview that serves individual survival, development and social communication (**Forshaw, 2016a, b**). Yet, in the present paper an even wider context for consciousness is offered, in which our individual mind is seen as a part of a larger universal consciousness, itself being instrumental in the entire fabric of reality (**Meijer, 2019a**). In other words, each conscious element in nature and thus each individual is implicitly part of a universal consciousness, for humans: *we are in consciousness*, implying the position of idealist ontology, albeit based on the fundamentals of quantum-(bio) physics and cosmology. This concept integrates a non-material mental framework, submitting that information represents a basic building block of nature (**Meijer, 2012**), an idea that was earlier framed as protyposos by **Görnitz and Weizsäcker, (2012 and 2016**. This concept is also based on our earlier consideration of brain that is encompassing an extended mind (**Meijer, 2015**) and the earlier treated

observation that life processes are sustained by a generalized biophysical principle of discrete pattern of electromagnetic wave frequency bands (**Meijer and Geesink, 2016, 2017**).

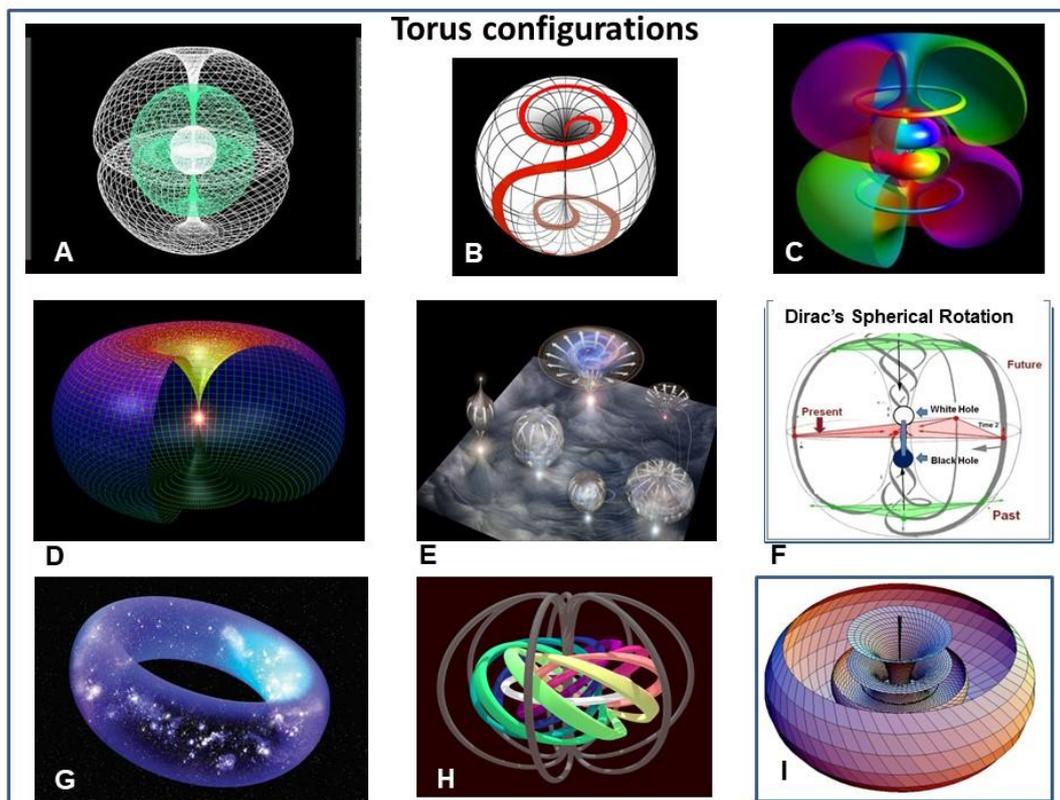
Consciousness, therefore, is not only a human faculty and implies a reflexive state that both involves information integration as well as subjective "feeling" of past and future events. It requires a graded complexity of life systems to deal with the requirements of multi-tasking and ecological maintenance. A central item in brain research is the question whether consciousness should be conceived solely as an *emergent* phenomenon, as related to the extreme neurological complexity of the brain or rather that the central nervous system is embedded in a much wider context in which it also *receives* (quantum) wave information, partly unrelated to the known senses. However, it remains an open question how humans develop self-consciousness and obtain basic knowledge of the type called qualia (**Chalmers, 1995**). The *hard problem of consciousness* is the problem of explaining how and why we have qualia or phenomenal experiences and how sensations acquire characteristics, such as colors and tastes. A very interesting treatment of the quantum models of consciousness research, as reviewed by **Meijer and Raggett, (2014)**, was given by **Wolf-Meyer and Cochran, (2015)**, in the framework of anthropology of science in general.

**Kozyrev, (1997)**, considered that all life-forms might be drawing information from a spiralling source of energy. He suggested that life could not be formed in any other way, because it is actively drawing off this spiralling vortex like energy to sustain itself. In this sense, we can think of the living system as possessing efficient resonators for tuning into geometrically organized energy, most likely in the form of toroidal flux patterns. There are recent proposals for toroidal models in the functioning of specific brain cells, neuronal networks, functional parts of the brain as well as the whole brain (**Tozzi and Peters, 2015; Knierim and Zhang, 2012**). The findings of Tozzi and Peters, suggest that nervous structures process information through topological as well as spatial mechanisms (see later). The authors embedded the brain in the 3D space of a Clifford torus and looked on cortical surfaces for antipodal points or shapes in relation to the topological hallmark of a hypersphere. By fMRI scanning reproducible topography and propagation has been found through subsets of regions that are shared across multiple trajectories. For example, it has been hypothesized that hippocampal place cells create topological templates to represent spatial information. The spherical structure displays a double torus shape, *i.e.*, the trajectory followed by a particle inside the torus is closed. The natural candidate for such a toroidal information flux is the spatially embedded network of the so-called human connectome: a comprehensive map of neural connections in the brain, that may be thought of as its "wiring diagram". More broadly, a connectome would include the mapping of all neural connections within an organism's nervous system and represents a non-stationary, highly dynamical structure characterized by complex topological geometry (**Atasoy et al, 2018**). Toroidal information flux (see **Fig. 5**), was also postulated by us to provide the basis for the existence of consciousness at different scales of the Universe. There are distinct reasons to choose the multidimensional symmetrical aspects of the double vortex torus, a geometry that may mimic a combination of transversal, longitudinal and circular waves (**Haramain, 2014; Bjerve, 2015; Amiot, 2013; Meijer, 2018**).

The nature of electromagnetic toroidal excitations, as developed in physics, was reviewed by **Papasimakis et al, 2016**, and their interactions with inorganic matter by **Tsytoovich et al, 2007**, while potential role as information collectors and carriers in life systems have been discussed by us earlier (**Meijer and Geesink, 2016, 2017**). Matter and thus particles can be seen as condensations of force fields that interact and both can be described with quantum information, that is actually a form of energy (see later). The special property is to bring the various types of field information together. In quantum theory, energy is quantized: thus, it consists of discrete vibrational units (vibrating strings or loops). The space is also quantized according to the theory, thus divided into small space parts. This

matrix of such space units is usually called space foam, bearing units that function as operators. Known examples of such elements are twistors (Penrose), clearly related to nested torus geometry (see Fig. 5 I). As mentioned above, such units are supposed to operate on every fractal scale, from very small (Planck scale) to very large (black holes), and can be conceived as the collection points of the various force fields: gravity-, dark energy-, zero-point energy-, electromagnetic-, and Higgs fields etc. In this manner, such operators integrate quantum information and store it on the edge of each fractal unit, a 2-D hypersphere that in the case of the black hole was called the "event horizon". Thus, quantum information, like energy, is retained in this manner. **Verlinde, (2011)**, used the holographic principle for his entropic gravity theory, invented by the Nobel laureate **'t Hooft, (2007, 2016)**, (see for holography aspects of the cosmos, **Sieb, 2016; Batiz, 2107; Alfonso-Faus, 2011**). *The leading principle of holography is that every object is fully described with information gathered on a screen around the object (the event horizon)*. It follows that also galaxies, suns, planets and likely the entire universe and even life systems are also to be regarded as toroidal organized information fields each projecting digital information on their respective event horizons.

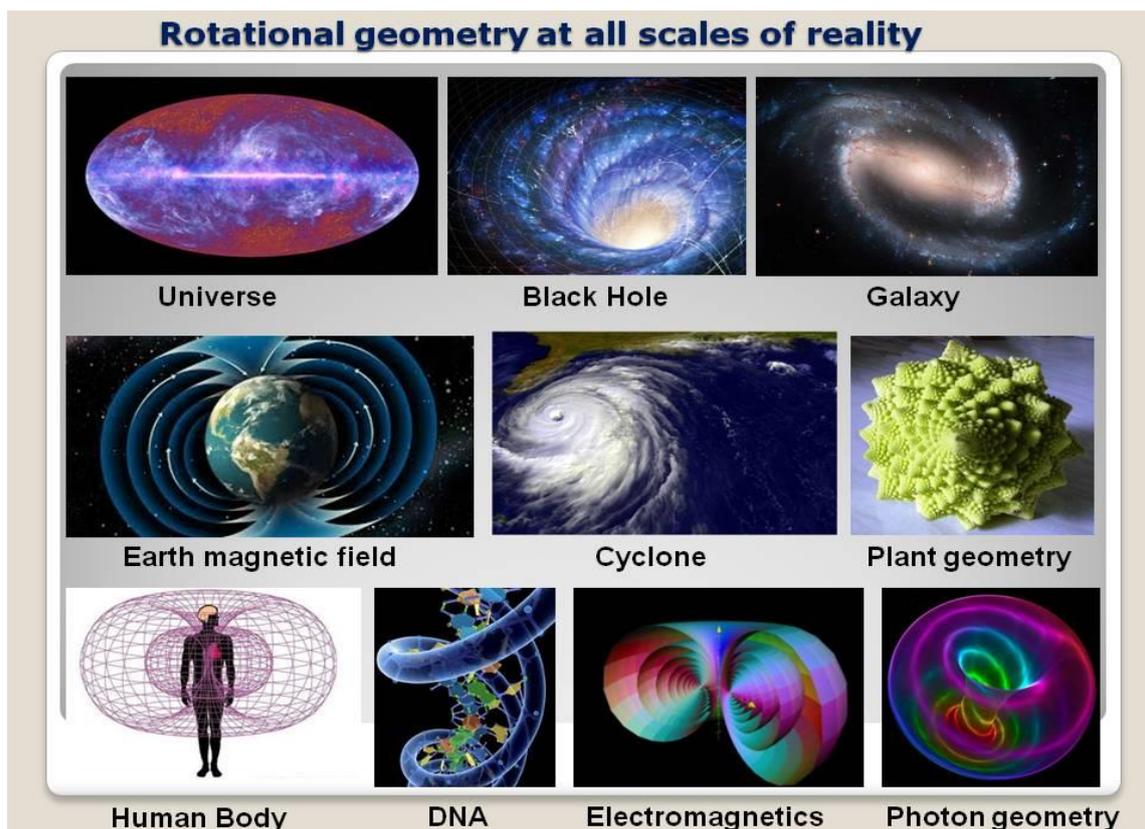
According to classical information theory, information always arises through *interactions of wave-particles* and, entropy of information represents the *potential* to ask yes/no questions in such an event with regard to a particle system (**Lloyd, 2007, Meijer, 2013**). According to these concepts, information is in fact the sum of *expected* information obtained from such yes/no questions. An example is DNA in our cells which in itself contains a lot of *potential* information (digitally expressed in Bits), but this can only be clearly expressed in the cell with the help of RNA to produce the gene products: the proteins. The intrinsic (hidden) information of each object is therefore the result of the entanglement of the stored (individual) information from its various constituting particles, providing a sort of global information store of it. This information is fed back a universal information matrix, that therefore is dynamic in time (**Keppler, 2013, 2016**). The zero-point energy field, (**Laszlo, 2007, 2012; Setterfield, 2002; Nation et al, 2012**), is an obvious candidate for information storage.



**Figure 5.** Various modalities of toroidal geometry: A: Nested torus structure B: Torus trajectory (red) C: Atomic structure as double torus, D: Filled space-time structure with singularity, E: Torus network, F: Dirac spherical rotation showing toroidal trajectories in relation to time G: Donut model of the universe, H: Knot structure in torus as metaphor for attractor/standing wave, I: cartoon of a twistor as a supposed space-time unit.

## 5.2 Cosmological and Holographic Aspects of Consciousness

In the previous section, we mentioned that even space-time itself may be derived from the above-mentioned quantum fluctuation field and, in particular, through the entanglement of quantum information that is locked in through processing in a connected a wormhole modality. Such wormholes now appear to be present at every fractal scale in the universe up to the Planck scale (**Fig. 6**). In the latter, it constitutes the aforementioned background framed as *quantum foam* (**Haramain, 2016; Ford and Roman, 2000; Lloyd, 2007; Loll, 2011**, see also Wikipedia/quantum foam). It is assumed therefore that information entering a black hole from the outside is never lost, but, as mentioned above, is rather is being projected on its outer screen, called the “*event horizon*” (**Maldacena and Susskind, 2013; Pourhasan, 2013; Haggard and Rovelli, 2014; Susskind, 2016; Lloyd, 2007**).



**Figure 6.** Toroidal geometry shows identified structures in the whole cosmos, from macro-(left above) to micro (right below) scales of the fabric of reality. The inset, left below, depicts the supposed nested toroidal geometry of the human body, heart and brain.

The collective information of all entangled black holes in the universe, may be holographically projected from the earlier mentioned 2-D- information radiating screens into a 3-D representation of our world.

Yet, it is presently discussed in cosmology whether the emitted waves either represent chaotic information or coherent information. Such coherence could, for example, arise by constructive interference with existing information in the universe and the resulting information could be instrumental in updating the supposed general knowledge field (**Bohm et al. 1980, 1987, 1993**). A recent theory (**Pourhasan, 2013; Haggard and Rovelli, 2014**), claims that information can also pass through the black hole structure, via the connecting wormhole (a sort of short cut in space-time) to arrive in an intrinsic "white hole", that instead has an anti-gravitational character. Some believe that final fusion of all black holes will yield a giant one that can disperse the stored integral information into a new version of our universe (see inset F in **Fig. 5**), in a rebound or cyclic operating mode.

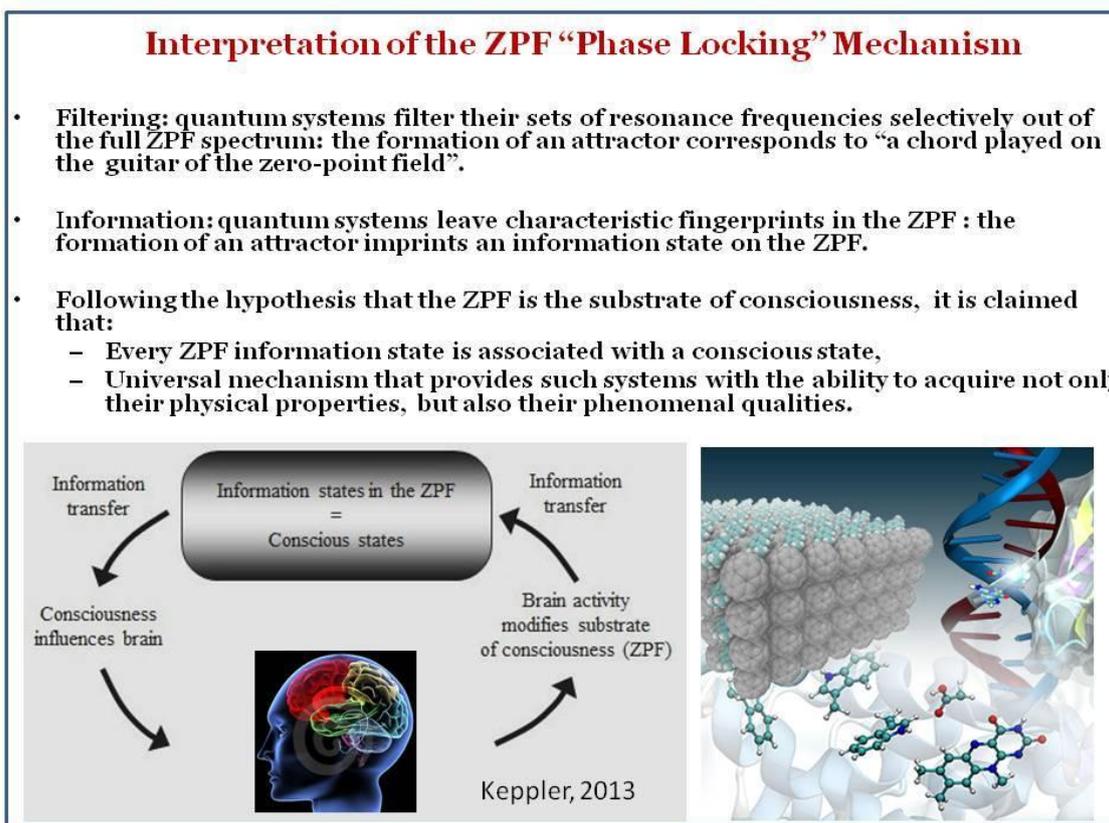
This model for the final fate of our Universe (the so-called big bounce, **Meijer, 2015**), might predict that information of a newly formed universe is integrated in a *nested* configuration with the preceding one (**Haggard and Rovelli, 2014; Poplawski, 2010**, see **Fig.10**). The nested torus structure therefore can be seen as a fundamental aspect of quantized spacetime. Interestingly, twistor geometry (**Fig. 5**), that was intended to unify quantum mechanics and general relativity by unraveling the phenomenon of gravitation, can also be used for solving non-linear Schrödinger equation to obtain solutions for *soliton wave phenomena* (**Dunajski et al, 2004**). As earlier treated, **Haramain et al., (2016)**, postulated a collective wormhole background on the Planck scale (see **Fig. 13**), that may underly our reality. The presence of a priory information could explain the partially directed character of biological and cosmic evolution, as have also be indicated by **Melkikh and Khrennikov, 2016**, see also **section 6**).

Most investigators agree that maps of the universe clearly indicate that the visible cosmos is fractal (**Alfons -Faus, 2011; Anjamrooz et al, 2011; Linden, 2017; King, 2008, 2011; Gaité, 2018**) although the discussion on this goes on (see also Wikipedia, Fractal Cosmology). A fractal is a *self-similar* geometric pattern, meaning that the whole pattern is always exactly contained within its parts, as in a hologram and similar patterns recur at progressively smaller scales. By zooming in on a massive cluster of galaxies, the self-similar structure of the universe becomes evident. Most fascinating is how certain snapshots of the far universe look similar to the fractal structure of a brain cell network, (**Werner, 2010, Leffert, 2019**). Fractals, as mathematical entities, are infinite and this is clearly demonstrated the case of computer-generated fractals. We emphasize that the information processing involved should be seen in a scale- invariant holographic context, which is supported by the increasing evidence for a holographic universe (**Ashfordi et al, 2017**), in which at the blackhole level a distinct discretization of spacetime may be observed (**Picato, 2017**). As mentioned earlier, EMF oscillations were measured associated with black holes with frequencies that were fully compatible with our GM-scale values (**Rezolla, 2003, Geesink and Meijer, 2016**). Inspecting nature as a whole, fractal geometry can be observed not only in the cosmos but also in many natural forms such as trees, plants, lightning, clouds, rivers, crystals, blood vessels, veins, mountains, the brain, snowflakes, shorelines, lungs, and other parts of animal and human anatomy (**Lefferts, 2019, Fig.6**).

Dynamical systems in the physical world tend to arise from dissipative (actively spreading) systems, a process that always includes some kind of driving force that maintains its motion. The dissipating driving force tends to balance the initial transients and settle the system into a typical, future directed, behavior, known as an *attractor* (**Keppler, 2013, 2016, Fig. 7**). An attractor can even constitute a complex set with a *fractal* structure, known as a *strange attractor*. The latter aspect promotes a *collective and coherent* behavior that can lead to flux-maximization. In the framework of the present model for brain function, both the subjective unconscious and conscious aspects (**Tammietto, 2010; Jahn and Dunne, 2004; Bernstein, 2005; Schwartz et al 2005; Rousseau, 2011**) can, in

principle, be modeled as information flow and recurrent storage as taking place in a nested toroidal setting, since the human brain organization clearly shows functional *circuitries* and obvious *fractal* properties (**Gardiner et al, 2010; Bieberich, 2012**).

Our suggestion, here, is that the brain is embedded in such an information storing hypersphere, which may help to solve long standing questions concerning our psychological activities such as mind-wandering, memory retrieval as well as the ability to connect past, present and future events (**Tozzi and Peters, 2015**). The human brain thereby exhibits the unique ability to connect past, present and projected future events in a single, coherent, toroidal screen, glued together in a mental kaleidoscope. Interestingly, these authors see the model of the brain hypersphere as a starting point for further evaluation of a brain-associated 4-th spatial dimension. In this extra dimension, mental operations may take place both in physiological and pathological conditions. The connectivity patterns at rest might constitute a “signature of consciousness”, reflecting a stream of ongoing cognitive processes. **Tozzi and Peters, (2015)**, speculated that conscious moments might be correlated with specific trajectory states in a “Clifford torus” structure. In this framework it has been proposed that features of EEG brain signals with spectral peaks in preferred bands ( alpha, beta gamma EEG waves) originate from such feature vectors in a 4D Euclidean space. One example of a recurrent toroidal type of brain activity, might be found in the periodically repeating pattern of so-called grid cells in the brain. These patterns have therefore been related to a supposed toroidal architecture of brain wave attractors (**McNaughton et al., 2006**).



**Figure 7:** Filtering of resonance frequencies from the ZPE field (modified from **Kepler, 2015**), by a phase-locking mechanism yields the qualia for our brain function. In reverse, the quantum brain leaves fingerprints in the ZPE field and the resulting dynamic and permanently updated ZPE constitutes the very substrate for consciousness and life processes (inset below right).

We have earlier proposed the hypothesis that if the brain is exposed to coherent electromagnetic fields in the form of discrete infrared waves, for example related to a zero-point energy field context, **(Geesink and Meijer, 2016, 2017)**. The brain may collect information through resonance of wave information, producing local wave attractors; **(Keppler, 2013, see Fig. 7)**. An attractor is defined as an assembly of vortex like fields, whose state evolves in time. Attractor networks in brain are considered to be built from nodes (for example neurons) that are typically recurrently linked (loops) with edges (like synaptic connections), and the dynamics of the network tend to stabilize certain patterns, at least locally, that therefore can be designated as attractors. For example, a memory stored in long time memory may be considered as a so-called point attractor, a sub-network of strongly connected neurons. An attractor can also refer to a collection of states that will eventually attract neighboring states toward that collection. In such a manner self-awareness may be created through folding along vortex like fields.

Many scientists have earlier suggested that basic information reaches our brain *from outside* **(Persinger, 2008, 2015; Grof, 1987, Jahn and Dunne, 2004)**, since the nervous system may also function as a *2016*, of subliminal signals. One could regard this process as a physically defined “extrasensory perception”. Evidently, we have to take into account a “sixth” sense in the form of a *vibrational, resonance sensitive macromolecular apparatus* in each of our cells **(Hameroff and Tuzcinsky, 2015)**. The particular cellular sensors are composed of flexible three-dimensional structures of proteins, oligo-nucleotides and elements of the cell skeleton, that mutually communicate through discrete wave resonances and are sensitive to fluxes of photons, phonons, excitons and related quasi particles such as polarons (solitons) and polaritons. These receivers act at the same time as receptors and emitters of quantum information, and operate as resonant oscillators with specific resonance frequencies, coupled with a natural quantum field **(Rouleau, 2014)**. This bio-sensing apparatus, situated in an apparently (bio)electromagnetic cell, was tentatively called the *electrome of the cell* **(Fig. 1, de Loof, 2016)**, being under the continuous influence of natural occurring internal as well as external electro-magnetic fields **(Meijer and Geesink, 2016, 2017)**. In this respect it is worthwhile to mention that, based on quite solid evidence, the brain has been described as an electromagnetic workspace **(McFadden, 2007; Pocket, 2012; John, 2001)**.

Quantum states, as related to discrete far-infrared waves, therefore, were also be considered as co-instrumental in the astrocyte/glia/neuronal networks that may play a role in cognitive processes (see: **Pereira and Furlan, 2007; Pereira, 2007**). In this respect the inter- and intracellular  $\text{Ca}^{2+}$  gradients and ion-oscillations may play a pivotal role since  $\text{Ca}^{2+}$ , due to its electron constitution can function as an outstanding information carrier **(Pereira and Furlan, 2007; Meijer and Geesink, 2016; Meijer, 2015)**. Especially the established spiral wave movements of Ca-ions, called cyclotron modes, are highly promoted by terrestrial magnetic fields **(Zioutas, 1996)**. Cells that are normally rather refractory for external EM wave modalities, become very sensitive to such radiation via perturbation of cytosolic  $\text{Ca}^{2+}$  oscillations. Rotating spiral  $\text{Ca}^{2+}$  waves have been reported in many studies (see for references in **Zioutas, 1996**) and photon energy is transformed in kinetic energy of the gyrating ion (gyro-resonance, see further in section 7.11). Quantum coherence of  $\text{Ca}^{2+}$  can also be attained in decoherence shielded ion-channels **(Bernroider, 2003)**.

### 5.3 Multi-dimensional Space-time, Including a 4th Spatial Dimension

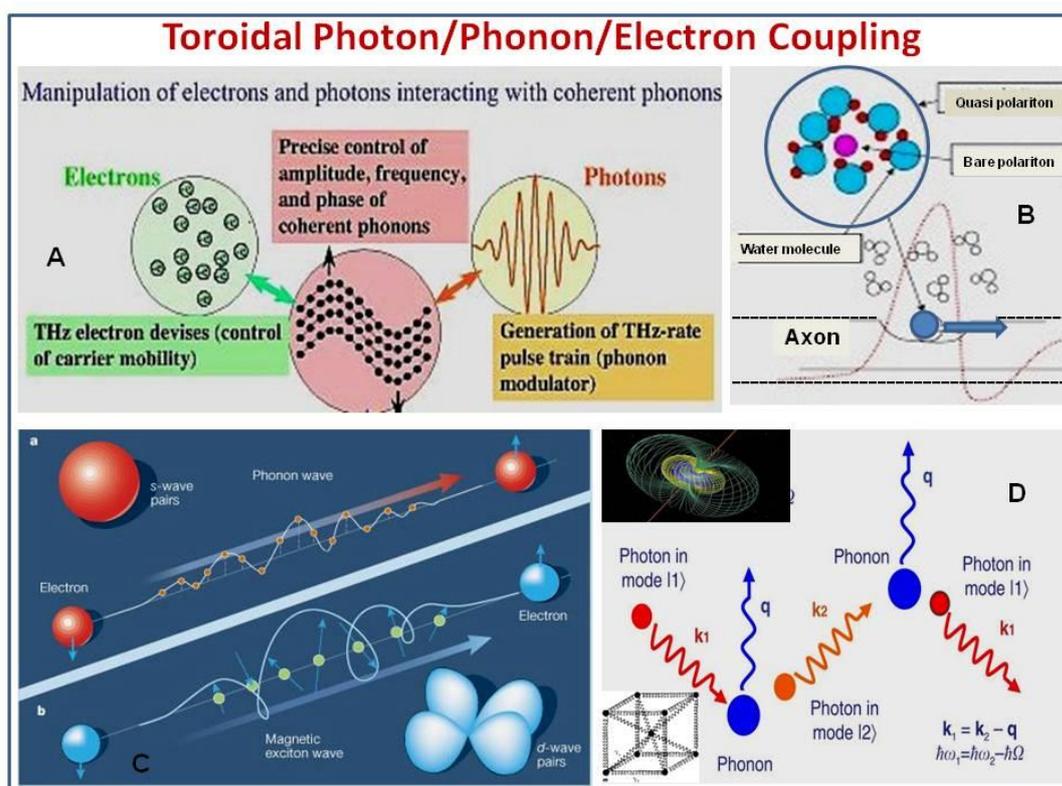
Kaluza’s theory **(Gabella, 2006)** derived the electromagnetic field extending throughout the first three dimensions of a 4D-space. It was postulated that only a 4+1 space-time structure, (thus with an extra spatial dimension), allows a unity of relativistic and quantum physical reality **(Beichler, 2012c)**, including time-symmetric operation and backward causation **(Meijer, 2012 and 2015)**. This also

allows causal and tensed-time modalities that are essential for self-consciousness and reflection (Carter, 2014). Quantum information mechanisms were recently used to model human consciousness as well as the unconscious in relation to conscious perception (Martin et al, 2013), in which various modalities of non-locality were discussed. Of note, entanglement and non-locality may not only apply to spatial separation, but also a temporal one. It was proposed by Martin et al, 2013; Baaquie and Martin, 2005 that archetypical information can be stored as quantum information in appropriate fields and that consciousness may be controlled by quantum entanglement from outside the classical 3+1-D space-time configuration, in an extra 4<sup>th</sup> spatial dimension (see also Sieb, 2016, Sirag 1993, Smythies, 2003, Carter, 2014, Wesson 2014, Luminet, 2016).

Another major finding is that physical information should be seen as a modality of energy and that information and energy can be mutually converted to each other (Berut et al, 2012; Toyabe, 2010; Peterson et al 2016), confirming previous ideas on three fundamental building blocks for the fabric of reality (Meijer, 2012): matter, energy and information. A study of Aharonov et al., (2013), even indicates that information can be physically separated from the matter it describes.

### 5.4 Biophysics and Brain Signaling Function of Bio-photons and Solitons

Importantly, Wang et al., (2010), presented a clear experimental proof of the existence of spontaneous biophoton emission and a visible light induced delayed ultra-weak photon emission, recently reviewed by Rahnama et al., (2011).



**Figure 8:** The formation of phonon/electron quasi-particles such as polarons (solitons) and photon-electrons like polaritons and their interactions (A), B: Polariton propagation along neuronal axons in brain. C: Phonon dressing of electrons. D: Phonon/ photon interaction in matrix.

In their experiments they used *in vitro* freshly isolated rat's whole eye lens, vitreous humor and retina. As a consequence of their findings they proposed that the photochemical source of retinal discrete noise, as well as retinal phosphenes, may originate from natural bioluminescent photons within the eyes (**Bokkon,2009 ;2013**). Thus, a potential candidate is a photon/phonon-instrumented messaging network, that may operate parallel with neuronal transmission apparatus, as described extensively by **Dotta et al., (2013)** and **Bókkon et al., (2009)** and on an electromagnetic basis.

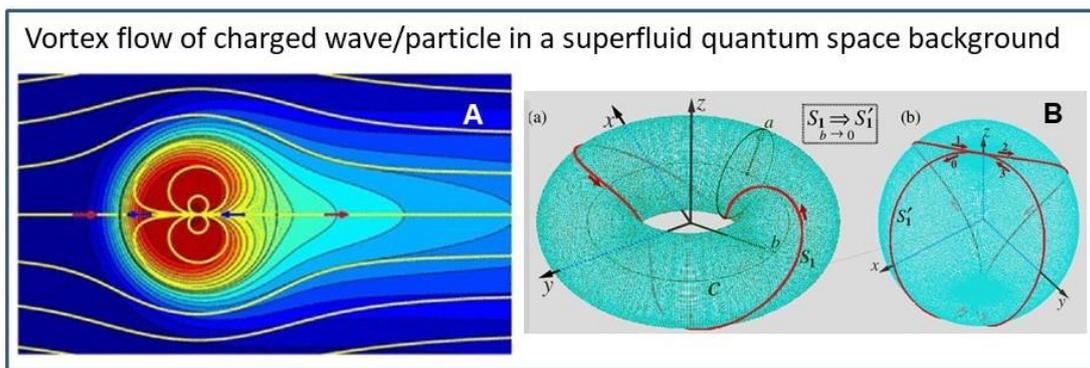
The earlier mentioned classical studies of **Popp, (1994)** and **Fröhlich, (1968)**, respectively, on the morphogenetic guiding role of bio-photons and phonon/solitons, in cell systems seem to be compatible with each other (**Meijer and Geesink, 2016**). **Rouleau and Dotta (2015)** and **Muehsam and Ventura (2014)** pointed out that, at atomic and sub-atomic scales, biological systems can be influenced by subtle energies and that these enable a higher order discourse that influences the metabolic and electromagnetic output of cells. This system can principally interact with outer electromagnetic fields such as the earth magnetic field (**Rouleau and Dotta, 2015; Persinger, 2016**) and is orders of magnitude more rapid than the neuronal transmission system. The efficacy of such a non-chemical communication system are fully in line with findings on bio-photonic information processing in microtubuli (**Mavromatos, 2002**). Important in this respect is the concept of quasi-particles, such as polarons (also called solitons) and polaritons that in fact are electrons dressed with phonons or photons respectively, that largely changes electron mobility and matrix interactions.

**Georgiev and Glazebrook, 2018**, presented a detailed analysis of the molecular structure of the synapse, and concludes that the best candidate for the regulation of exocytosis is a group of three proteins collectively referred to as “Soluble NSF Attachment Receptor” (“SNARE”) proteins. He showed that the conformation of these proteins at the neural synapse facilitates the creation of a quantum quasiparticle called a *Davydov soliton*. They further proposed a model based on quantum tunneling of this soliton across a potential energy barrier, and shows that the model is able to reproduce the experimentally determined exocytosis probability *and may thereby promote entanglement of neuronal structures*. **Bessler (2019)**, in a transparent analysis of this work, links this mechanism to the innovative studies of **Flohr, 1998**, who showed that impairment of consciousness by anaesthetic agents always involves the N-methyl-D-aspartate (NMDA) receptor, a glutamate receptor which has also been shown to play a pivotal role in exocytosis, and thereby in the creation of extensive neural networks. He suggested that this work of Flohr could well be related to the quantum entanglement aspect of Geogiev as a top-down process of exocytosis mediated neural integration. Thus, *solitonic information transfer*, operating in a top-down mode could guide the related cortical template to a higher coordination of reflection and action as well as network synchronicity, as required for conscious states.

## 5.5 ZPE/ SFQS Field and Interactions with Life Organism and Brain

The vacuum is filled with scalar fields that serve as order parameters for superfluidity, being quantum phase coherent over macroscopic distances. Superfluid quantum space (SFQS) concepts have been developed by **Fedi, 2016**, and **Sbitnev, 2017** and recently reviewed by **Fell and Sbitnev, 2017**, in the framework of plasma physics. A hypothesis has been formulated, according to which, space is a quantum superfluid and fermions absorb space's quanta (SQ), generating an attractive force, which corresponds to gravity. According to **Fedi, 2016**, the mechanism of absorption is based on the description of fermions as vortices in a superfluid quantum space (SFQS), similarly to nano-vortices occurring in superfluid helium-4, i.e. as dynamic topological defects of SFQS. To compensate this absorption, emission of virtual photons would occur, capable of explaining the existence of charged particles. The exchange of SQ occurring between two adjacent vortices would, moreover, justify the

strong interaction leading to the complete unification of the four fundamental forces. The reasons for considering fermions and other particles as superfluid vortices of SQ are several. One could, for instance, explain the appearance of particle- antiparticle pairs from quantum vacuum as a perturbative phenomenon analogous to that described in a so-called Kármán vortex street, where pairs formed by a right- and a left-handed vortex occur due to a perturbation of the flow. In our case the flow may be represented by the gravitational field and the disturbance by other particles or stochastic perturbations of SFQS. The trigger to the formation of vortex-antivortex pairs in the fluid quantum space, corresponding to matter and antimatter within our analogy, might be a phase transition similar to the fluid vortices providing a new basis to describe the wave equations of fundamental fermions. In this direction, Sbitnev (**Sbitnev, 2012-2017**) considers quantum vacuum as a superfluid and applies quantum considerations to Navier- Stokes equations (see **section 7**).



**Figure 9.** *A: Steady vortex avenue confined by transfer flow with a dipole source inside and a uniform background flow outside. Yellow streamlines outside of the vortex area represent possible Bohmian trajectories B: Transformations of torus shown in (a) to the tori when the radius  $b$  tends to the radius  $a$ , or to the double surface sphere shown in (b) when the radius  $b$  tends to zero. Pilot waves of Bohm can be envisioned as motion of vortices guiding a particle along the optimal trajectory, in which the torus bears a wave pattern that accommodates all the information about the environment by reflection and therefore can fully simulate the particle until its final destination.*

Sbitnev describes vortex objects (vortex balls) that, unlike Hill's spherical vortices, show intersected streamlines (**Fig.9**) and satisfactorily reproduce fermions' spin by varying their orientation at each revolution. As far as the most appropriate vortex geometry is concerned, it is interesting to consider the following evolution: vortex tube to vortex torus to quasi-spherical torus, since it could be able to account for the main mechanism i.e. the absorption of SQ (gravity) and the consequent emission of virtual photons, which accounts for Coulomb's force and is necessary to maintain energy balance in spite of SQ absorption. Furthermore, if SQ in the vortex, in order to return to their position needs double the time than it takes for the vortex to complete one turn around its vertical axis, thus the system would have  $\text{spin}^{1/2}$ , necessary to describe fermions. Indeed, the system would return in a given state after a rotation of  $720^\circ$ . We see then that the quantum potential of a particle, described as a super-fluid vortex of SQS, is determined by the vortex itself, i.e. by its spin as angular momentum. The mechanism of absorption would be due to spin and viscosity (although minimal), while pressure in SQS would play a fundamental role in keeping the vortex indefinitely active. The origin of SFQS's pressure has of course to be sought in events around the Big Bang, when it had to be infinitely high.

Finally, the description of photons as phonons propagating through a superfluid space would reduce waves which exist in nature to only one type (propagation-medium-dependent). One could therefore even state that that a superfluid approach may explain nature without extra dimensions, strings,

gravitons or other complex reasonings. Within this superfluid reconsideration of the universe, it is impossible to keep fundamental forces separated and to keep them separated from particles, since we see that everything is expression of the kinetic energy of space's quanta (spin mainly), and of viscosity, density and pressure of superfluid quantum space. From vortices of SQ we have indeed mass, charge, fundamental forces, light etc. Only a few things then still appear to be really fundamental in nature and one might attend an enormous simplification in the physics of the present century, up to only having a superfluid quantum space and its hydrodynamic behavior.

*There are many analogies between photon and phonon.* In the energy eigenvalue of any eigenstate  $\psi_n$  of photon, expressed as  $E_n = (n + 1/2) k\omega$

<sup>1</sup>  $k\omega$  is vacuum (SQS) contribution, as well as for a phonon, where the harmonic oscillator eigenvalues for the mode  $\omega_k$  ( $k$  wave number) are  $E_n = (n + 1/2) k\omega_k$   $n = 0, 1, 2, 3, \dots$

### **Both photons and phonons:**

- are bosons,
- possess wave-particle duality,
- obey the Doppler effect,
- are symmetric under exchange,
- can be created by repeatedly applying the creation operator,
- share the formula of momentum,
- can produce photoelectric effect and Compton scattering thanks to their momentum,
- can have a spin. In this case photon would be a special spin-1 phonon,
- can form squeezed coherent states,
- can interact via parametric down conversion

When a photon is described as a phonon in SFQS, the energy it carries would be justified within the quantum phenomenon of second sound, occurring in this case in SFQS.

*Conclusion: the physical definition of SFQS and ZPE field are closely related, yet it should be realized that the ZPE concept mainly reflects the frequency of quantum fluctuations of the field, while the superfluid quantum space defines the total overall dynamic field structure that may underlie the fabric of reality in which also our world is embedded*

### **5.6 Photon/Phonon- and Soliton-mediated Communication in Brain.**

A few years ago (**Geesink and Meijer, 2016**) we stated: "Electromagnetically seen, we may be living in a "diluted plasma" with natural coherent quantum resonances, that can be approached by equations for standing waves". In this respect the potential role of solitons (polarons, being electrons dressed with phonons) were highlighted (**Meijer and Geesink, 2016**). Soliton waves exhibit remarkable resistance to distortions and noise interference, keeping shape and velocity even after collision with each other by which they can penetrate into materials without losing their identity. Therefore, they can function as information carriers in the entire universe, and were present at the beginning of life. They can also be

regarded as energy-informational system in whole organisms, brain and its components such as proteins, DNA and bioplasm (**Adamski, 2019, Meijer and Geesink, 2018, Melkikh and Meijer, 2018**). Soliton interactions with macromolecules result in self-trapping of electrons in localized soliton states. Due to these properties they can guide protein folding and also can pass outside the brain in a sort of extra-cranial communication (**Adamski, 2019** and references therein). Phonon waves can therefore be considered as photon activity expressed as sound vibrations within a solid matrix and the physical similarity between both types of energy are described before in section 5.5. Photon-like waves are permanently present in our body through resonance, since the organism is embedded in the zero-point energy field and are also generated in the brain as, so called, bio-photons.

Dynamic coupling of the brain with ZPE /SFQS field modes has been proposed as a universal mechanism underlying conscious systems, (**Keppler, 2016, Sbitnev, 2016**), based on stable attractor dynamics by which the ZPE field/ Superfluid Quantum Space, in fact, becomes a *substrate of consciousness* (see **Fig. 7**). In this framework the brain, as a resonant oscillator, extracts or rather filters a wide variety of phenomenal nuances from an all-pervasive stochastic radiation field in the form of phase-locked ZPE wave information states, that are supposedly linked with or correspond to conscious states (indicated in **Fig. 7**).

Thus, Keppler envisions discrete long-range EM frequencies, that are expressed in brain in the well-known gamma and theta oscillations and according to the author are *related to coherent oscillations in cell water*, resulting in information integration as conceptualized by **Tononi et al, 2008, 2015, 2016**. ZPE field is traditionally seen as the domain for quantum fluctuations of pairs of wave/particles and their antipodes (**Daywitt, 2009; Setterfield, 2002**). Of note, virtual photons, that are also instrumental in the generation of van der Waals forces known from chemical binding, are produced during particle/antiparticle pair fluctuations (*Dirac Sea*). Thus, photons originate from the vacuum, and are generated if dipoles in the field rotate due to interaction with moving charges in, by which a magnetic induction field is produced. In this manner, free charges perturb the vacuum by polarization. (**Daywitt, 2009**). A major problem in physics is the estimated 122 orders of magnitude difference between the energy density at the cosmological scale and that predicted by the quantum field theory at the Planck scale (the so-called "vacuum catastrophe"). Recently **Haramain and Val Baker, (2019)**, applied a generalized holographic model and found a potential solution by considering the total mass energy density in a geometry of the universe as a spherical shell. **Huang, (2013)**, approached the same item using a superfluid universe model, seen as a self-interacting complex scalar field.

Photons are intrinsically quantum objects and, by their nature, long-distance carriers of information. **Annala (2016)**, stressed their importance in relation to consciousness. It seems clear that properties of a molecule cannot be inferred from properties of its constituent atoms alone, since they also rely on photons that couple them to their surroundings. The ultra-rapid brain responses, discussed in a previous publication (**Meijer, 2014**), were seen as being related to photon/phonon mediated communication, in line with the findings of **Bókkon, 2009, Dotta, 2013 and Persinger, 2015**. Yet, in this context, the role of the earlier mentioned 4D-mental holographic domain coupled to the concept of a *universal consciousness field* (defined as the implicate order by **David Bohm, 1980, 1987**) should be taken into account (**Meijer, 2019a**). In this respect, an ZPE stochastic electrodynamic field as postulated by **Laszlo, 2007, Keppler, 2016 and Caligiuri, 2015**, should be seen as the crucial "steering" modality that mutually communicate with the *whole nervous system of the organism*, including its neuronal networks with their conscious and non-conscious aspects.

Bidirectional communication between the brain and such an extended mental workspace was proposed to occur by toroidal integration of the above-mentioned information spectrum in both the physical and mental domains (**Meijer and Geesink, 2017, se Fig.10**). Thus, such a mutual communication process is seen as being instrumented by magnetic flux and photon/phonon/soliton mediated wave resonance and/or phase conjugation, between the proposed mental workspace and the associated neuronal/cavity landscape of the material brain. It is of considerable interest that Alzheimer models showing memory loss in the hippocampus area, can be reactivated by photonic pulses into the corresponding cortical cells, using the technique of optogenetics. This procedure results in restoration of the retrieval of the particular lost information from the engram cells, likely due to formation of new dendritic connections and related protein synthesis, possibly via light sensitive proteins called channel rhodopsins, (**Tonegawa et al, 2015**). This technique may mimic the supposed photonic communication from the 4-D mental workspace as proposed in the present paper.

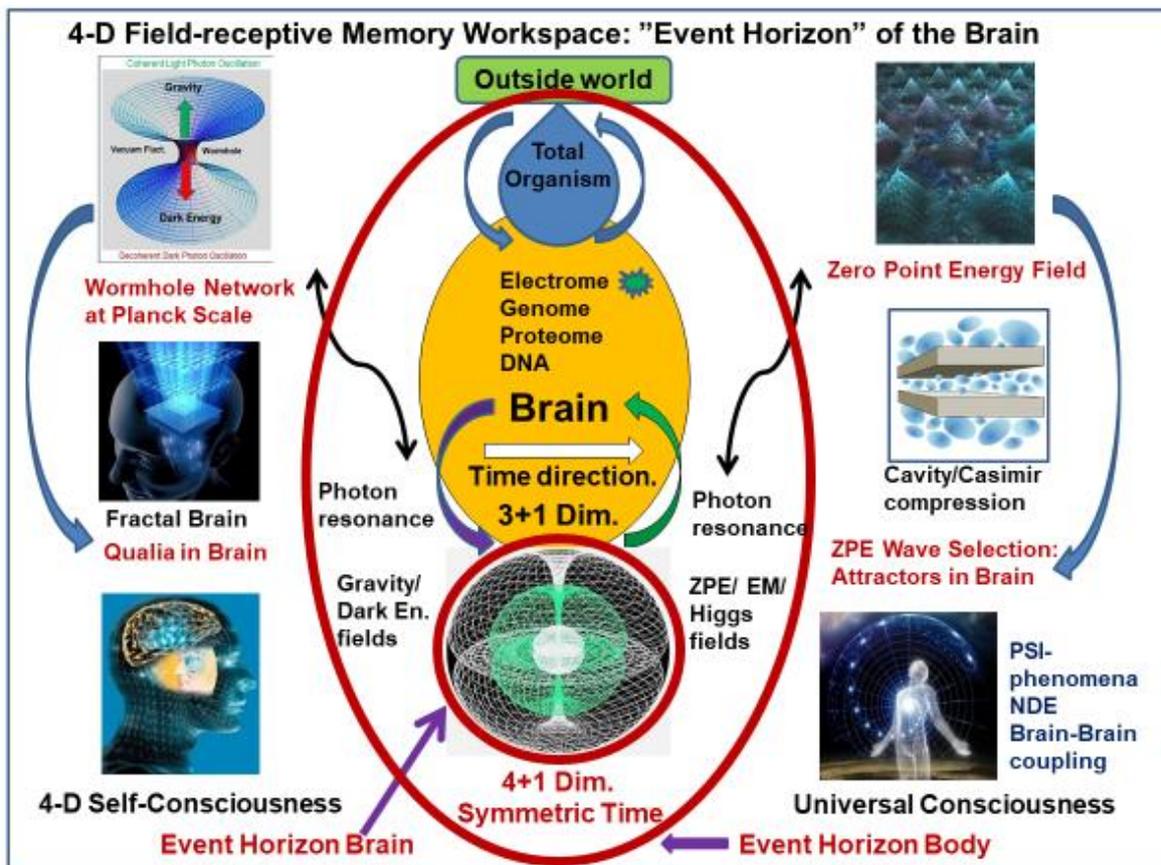
### 5.7 The Hologractal Event Horizon Brain concept

It was postulated earlier (**Meijer and Geesink, 2017**), that consciousness in the entire universe arises through, scale invariant, nested toroidal coupling of various energy fields, that may include quantum error correction. Such a toroidal process may cause the coupling of gravitational, dark energy, and zero-point energy fields, as well as that of earth magnetic fields (**Fig. 10**).

Through the supposed field-receptive workspace wave information may be transmitted into brain tissue, that thereby becomes instrumental in high speed conscious and sub-conscious information processing. We proposed that the latter crucial process generates self-consciousness and is conceived to be operating from a 4<sup>th</sup> spatial dimension (hyper-sphere). As treated before, the torus is envisioned as a basic unit (operator) of energy flow in space-time, among others collecting the array of discrete GM-frequencies that in concert represent an algorithm for coherent life processes.

The importance of the concept of the universe as a cosmic hologram has been earlier reviewed in a comprehensive study of **Currivan, 2017**, and was recently nicely reviewed by **Lefferts, 2019**. It was physically described in more detail by **St. John, 2018** and related to a fractal 5-D hologractal structure by **Linden, 2008**. In the brain, the proposed holographic workspace collects active information in its "brain event horizon", thereby producing an internal and fully integral model of the self. This brain-supervening workspace is equipped to convert integrated coherent wave energies into attractor type/standing waves that guide the related cortical template to a higher coordination of reflection and action as well as promotes the network synchronicity, as required for conscious states.

In relation to its scale-invariant global character, extensive support was found for a universal (cosmic) information matrix (**Meijer, 2019**). The presence of such a field-receptive resonant workspace may therefore provide an interpretation framework for widely reported, but poorly understood transpersonal conscious states (**Meijer and Geesink, 2017**, see next section) and also for an algorithmic origin of life (**Meijer and Geesink, 2018; Melkikh and Meijer, 2018; Walker and Davies, 2013**). In general, the manifestation of a universal consciousness points out the deep connection of mankind with the cosmos and our major responsibility for the future of our planet.



**Figure 10.** Modeling of brain/ mind relation in a 4+1-dimensional space-time framework (4+1 implies 4 spatial dimensions and one single dimension of time, on the basis of energy trajectories in a nested toroidal geometry. The opposing forces of Dark energy (diverging force) and Gravity (converging force) as well as discrete wave frequencies of electromagnetic fields, are instrumental in the generation and compression of individual life information. The human brain may receive quantum wave information directly derived from the Planck space-time level (left above) through quantum gravity mediated wave reduction, as well as through resonance with the ZPE field (right above). Our brain can perceive only 3+1 dimensions with the one-directional arrow of time. The material brain and its 4+1-D supervening field-receptive mental workspace should be seen as an integral whole, until bodily death of the organism. The 4<sup>th</sup> spatial dimension allows individual self-consciousness since an extra degree of freedom is required for self-observation and reflection, while in the mental context the time dimension is symmetrical, allowing to integrate past and future-anticipating events. The 4<sup>th</sup> spatial dimensions is also assumed to accommodate the bidirectional flow of information between the domains of self-consciousness and universal consciousness. The bottom-up information flow from the Planck scale, combined with top-down information conjugation from the ZPE field, constitutes the event horizon of the brain, also integrating gravitational and dark energy related force fields, supervening the physical brain. Event horizons of the brain and the whole body are depicted in the red ellipse and circle respectively.

The striking similarity with the 3-D brain as a “personal universe” (Meijer and Korf, 2014), implies a symmetry breaking as a dominant feature of reality. In this respect, it was put forward earlier that a hyperspherical universe, in which the present universe is nested in a surrounding toroidal hypersphere, can directly be derived from Einstein’s relativity theory on the basis of a re-interpretation of the Klein-

Gordon equation, as performed by the famous Italian mathematician Fantappi  (see **Galloni, 2012, Chiatti, 2007**).

## 5.8 The PSI- framework of Consciousness and Discrepancies with Cerebral Structure

We hold that the collective field concepts, proposed above, may constitute an interpretation framework for poorly understood phenomena such as mental states such as intuition, telepathy, far distance observation as well as near death experiences (see **Radin, 1997; Beichler, 2012c; B kkon et al, 2013**) and other Psi phenomena (**Radin, 1997; Beichler, 2012b; Rousseau, 2011**), to mention only some of the many studies available on this topic. In addition, such a multidimensional space/time brain structure, being open to external electromagnetic and quantum fields, could also provide a reference frame for understanding of the reported time delay between experimentally induced actions of individuals and their conscious perception of the event (**Libet, 2001, 2006**). In addition, the subjective experiencing of qualia as well as the subjective experience of transpersonal and extra-sensory events such as clairvoyance and near-death experiences (NDE), seems compatible with such a model, (**Jahn and Dunne, 2004**). The NDE aspect is documented in thousands of international reports and nowadays open to scientific inquiry (**Lake, 2015; Greyson, 2010; Schwartz et al, 2005, B kkon et al, 2013**). NDE's can occur in life-threatening situations close to dying (asphyxia, near-drowning, traffic accidents and stroke). They can even be induced by deep meditation, that is with full awareness of one's own body (**Van Gordon et al, 2018**). With regard to stroke and heart failure. the specific components of this experience, often with a long-lasting psychological impact on the recovered patient, include so called out of the body experiences, tunnel visions, and a remarkable clear and holistic state of awareness, verbally reported by the particular patients, albeit in retrospect. This conscious state is claimed to occur in the apparent absence of the cortical activity and is clearly different from a general dream state since in that case abundant EEG's activity is observed in the cortical area.

The typical descriptions of a felt dissociation from the body, in addition to a *total life-panorama* (**Lake, 2015; Greyson, 2010; Schwartz et al, 2005; Pereira and Reddy, 2016**), as reported by a part of the NDE cases, may point to an access to a wealth of detailed information of non-neuronal origin, that only can be imagined assuming a radiant and resonant mind field (**Meijer, 2013, 2019b**), as proposed above. Such an external source of information resembles the concept of a "personal double" as earlier proposed by **Vitiello, 2001**. This availability of external information can largely influence normal cognitive brain function, and its presence is somehow persisting while other brain functions seem defective. This overall picture of NDE may therefore point at a supervening field character that is not directly dependent on normal brain activity and may operate from a fourth *spatial* dimension (see **Fig. 10**).

In addition, other highly subjective phenomena such as intuition and serendipity, that frequently represent crucial elements in major scientific breakthroughs and/or technological innovations (**Meijer, 2017a**), should be taken into account in this context. Breaking the barriers between brain and normally hidden information space that, by some, is interpreted as a perturbation of the "filtering" between the conscious and unconscious, may be at stake (**Meijer, 2019b**) and this is also widely discussed in relation to the potential effects of meditation and induced dream states on such phenomena, (**Jahn and Dunne, 2004; Bernstein, 2005; Schwartz et al 2005; Rousseau, 2011**). A recent paper of **Tononi, (2016)**, reviewing the earlier mentioned "integration of information concept" in consciousness, mentioned an interesting view of **Sullivan, (1996)** that *another type of consciousness* becomes manifest in meditative states that in fact can be considered as rather *information content-less*, and could reveal a normally hidden part of consciousness that is

normally masked or filtered away by the busy default activity of our brain (see also **Jahn and Dunne, 2004; Rousseau, 2011; Martin, 2013 and Schwartz et al, 2005**).

In this respect biophotonic information transmission also could play a role. Generally, neurologists are hesitant to accept bio-photons as an extra messenger system along with the prevailing related assumptions of the “neuron doctrine”. Yet, in physics the photon is the generally recognized carrier of information between atoms and molecules and (not only for this reason) perfectly fits into the context of a versatile and dynamic brain structure. This is certainly the case if photonic wave information would be protected against de-coherence in the brain environment through the influence of low- frequency phonons, realizing that a dominant aspect of de-coherence is via phonon coupling with the environment and that an acoustical mismatch between the immediate and wider environment of the quantum system could largely prolong coherent states at low frequencies (**Davies, 2009, 2014; Lambert, 2013, Marais, 2018**).

Any organism (and also organs like the brain) is considered as an open energy system, implying a continuous interaction with the environment. Yet, such an interaction must occur in a noise protected manner, that requires capabilities of feedback control. Indeed, James, Bergson and Huxley, and more recently, **Jahn and Dunne (2004)** as well as **Kastrup (2016, 2017)** speculated that part of the brain acts as a “filter” or “reducing valve”, by selectively blocking out external information so that only the registration and expression of a narrow band of perceivable reality is manifest. Possibly, in the course of evolution, the brain was adapted to eliminate most of those extra-sensory perceptions, being incompatible with the urgent needs of everyday survival. One hypothesis suggested a dual development of the brain, namely an evolutionary improvement of technical and logical abilities, at the cost of loss of contemplative/spiritual potential, (**Bitbol and Luisi, 2011**). In Kastrup’s studies the important suggestion was made that the normal filtering aspect of brain function can be largely decreased in a variety of special conditions that can be characterized as an evident *reduction* in overall brain activity. **Carhart-Harris and Friston (2019)**, in a lucid review on the potential mechanisms of brain actions of psychedelics, state that such agents relax the activity of a so-called *high level controlling summary system* that normally compresses information flow from lower centers, leading to ego-dissolution and liberation of compressed information due to an elevated entropic state. This leads to feelings of increased insight, cosmic unitive experience and interconnectedness as well as therapeutically relevant elevated self-knowledge and social openness on the basis of an awakening to the true depths of being. Even several directed procedures (listed in **Fig.11**) can be created to increase self-transcendental experiences and mystical states and open the doors to perception of universal consciousness, (recently treated in **Meijer, 2019b**).

## **5.9 Discrepancy Between Cerebral Structure and Cognitive Functioning**

The implicit suggestion of a *non-material* and *extra-corporal* mental workspace, that may supervene and complement our neural system is indirectly supported by observations in fNMR studies that *long-term memory is not correlated with scaled sizes of the brain*. For instance, Savants, that usually have normal brain size, can demonstrate a huge, almost disproportional memory capacity: entire novels and even complete contents of telephone books are memorized in detail in such cases. Even more impressive are the observations with regards to so-called hydrocephalic patients that have only 5% of normal brain volume (called micro-cephaly) and can show quite normal intelligence and social behavior (**Forsdyke, 2014; Feuillet et al, 2007; Mashoour and Alkira, 2013**). Other striking examples are patients with a largely destroyed forebrain that maintain a quite normal life (**Sasal et al, 2016**). Even the known split-brain patients that seem to develop two different types of consciousness

in, the isolated, right and left *halves* of the brain, in fact show this aspect. In addition, split-brain patients with disconnected hemispheres even perform better at some cognitive tests (**see Sasai et al, 2016**).

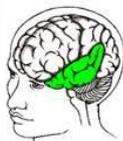
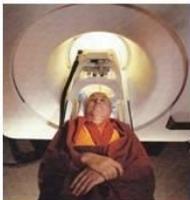
**Nahm et al, (2017)**, reviewed quite a number of striking cases involving brain dysplasias (abnormal cell development) and brain lesions (cell damage) indicating that large amounts of brain mass and its organic structures, even entire hemispheres, can be drastically altered, damaged, or even absent without causing a substantial impairment of the mental capacities of the affected persons. These exceptional individuals thus display a notable discrepancy between the condition of their cerebral structures and the quality of their cognitive functioning. This includes cases of gross hydrocephalus having global IQ's between 100 and 130 and verbal IQ up to 140. In some cases, they were married, having a job, while in one case such individual even spoke 7 languages. Thus, the macro- and microanatomy of the brain and its tissue layers differ drastically in people with severe hydrocephalus compared with people with normally developed brains. For example, brain structures such as the thalamus, the amygdala, and the corpus callosum were not visible at their usual positions in the scans obtained from the patient, described by **Feuillet et al. (2007)**, but were most likely pressed toward the cranium together with the layers of the 0.5- 1 cm cortical mantle, **Fig.19**.

**The Science of Self-transcendence and Neurotheology, How to Promote Mystical Experiences and Perception of Universal Consciousness**

**Self-transcendence correlates with brain function impairment**

B. Kastrup, 2017, J. Cognition and Neuroethics, 4, 33-42 and Sc. Am.



- Cerebral Hypoxia: Holotropic Breathwork, program. hyperventilation
- Deep Meditation: Long-term meditation practicing by monks
- Physiological Stress: Near Death experiences, G-force, fainting
- Electromagnetic inhibition: Transcranial magnetic stimulation
- Trance- induced inhibition : Psychographic imaging by media
- Chemical inhibition: Psychedelics : DMT, Psilocybine, and Ayahuasca
- Stroboscopic light therapy inducing release of de DMT in the pineal gland (ajna light/ lucia N 03)



**Figure 11:** *The feeling of the reality of a cosmic (universal) consciousness, was suggested to be promoted by a number of procedures, of which the listed examples have been experimentally tested/ and or investigated (see **Kastrup, 2017; Jahn and Dunne, 2004**).*

Often, such malformations result in impaired mental and motor skills, but apparently, this is not always the case. *The central question is if partial recovery from such conditions is due to plasticity of the remaining cells or, alternatively, is related to the increased volume of the, quantum informed,*

*aqueous brain compartments. The latter would provide extra “antennas” for receiving quantum information as a compensatory factor (see also section 7).*

Another case is presented in cases of *hemispherectomies*, how can we explain that the remaining brain structures and its neural activities can “know” that a “language center” is missing now, and how the remaining neurons induce and guide the duplication of this function in the still present hemisphere. **Majorek (2012)** argued that this activity requires the existence of a “higher control center” that would be able to detect this gap in function and to initiate steps that lead to its mending, and to imagine where such a control center could be located.

On the basis of these different cases of discrepancy between cerebral structure and cognitive functioning discussed above, some authors doubt that the brain serves as a sole comprehensive memory store, arguing that its function more closely resembles that of a receptor or transmitter of memory and allied cognitive processes (e.g., **Forsdyke, 2014**). **Cleeremans, (2011)**, in his “radical plasticity thesis” put the question: “how the brain learns to be conscious”. The author implies that consciousness arises as a result of the brain’s continuous attempts to predict not only the consequences of its actions on the world and on other agents, but also the consequences of this activity in one cerebral region on activity in other regions. Therefore, the brain continuously *learns to redescribe its own activity to itself*, so developing systems of *meta-representations* that characterize and qualify the target first-order representations. Such learned redescrptions, enriched by the emotional value associated with them, form the basis of conscious experience in interaction with the world, as a sort of signal detection of the mind. **Cleeremans, (2011)** stated: “Any theory of consciousness has to be able to explain why a person who’s missing 90% of his neurons, still exhibits normal behavior”. **Merker, (2007)**, reported on the purposive, goal-directed behavior exhibited by mammals after experimental decortication, as well as evidence that children born without a cortex are basically conscious. The author stated that properly assessed, the behavior of children with early loss of their hemispheres opens a unique window on the functional capacities of a human brainstem deprived of its cerebral cortex early in intrauterine development. The particular studies showed that these children smile and laugh in the specifically human manner.

In opinion of the present authors, the consensus concerning the crucial thalamo-cortical mediated consciousness, under normal conditions, still holds in spite of the abovementioned observations, but they may indicate that consciousness can be *learned or received* even when only the brain stem remains. The postulate of a supervening integral memory workspace in the present paper is very much in line with this idea. It is tempting to suggest that not only some sort personal brain is created within our organism, but that somehow, at the same time, an extra-neuronl personal information source is produced, that may be associated with the personal brain but is not reducible to it (see also **Wolf, 1985, 1989**). Both aspects of knowledge aquisition may operate in the framework of biological evolution and personal survival (**Meijer, 2019 b**). The human brain should in that case be rather viewed upon as an information interfacing system not only *connecting* individual and universal consciousness, but seeing our consciounees as *directly derived from* a realm outside our organism. Such a modality forms the very basis for the concept of an “*extended mind*” that is founded in the philosphy of so-called Idealism (**Goswami, 1990; Kastrup, 2016**).

## **5.10 The Generalized Music Principle Created from Cosmic Harmonics**

The role of musical sound in discrete wave frequencies in the induction of very complex geometric patterns was earlier treated by us (**Geesink and Meijer, 2016; Meijer and Geesink, 2017**) on the

basis of the famous experiments of Chladny (see **Rossing, 1982**), as well as the cymatics of **Jenny (1974)** and **Waller (1955)**, in which sounds create, clearly mathematical defined, distribution patterns of fragmented material on a flexible surface (see for this the illustrations of **Lefferts, 2019**). These intriguing observations are still broadly mentioned in more recent physics.

When the French physicist Louis de Broglie proposed the wave nature of electrons and other matter particles, he may very well have had musical harmonics in mind. De Broglie showed how the different energy levels of Niels Bohr's atomic model emerged naturally by describing electrons as standing waves of various frequencies, thereby generalizing the wave theory of light to material particles. Just as a guitar string can be plucked in certain ways to produce particular sounds, electrons in de Broglie's scheme are forced to oscillate in particular patterns, corresponding to certain frequencies and energy levels. Austrian physicist Erwin **Schrodinger, 1926**, developed de Broglie's idea further by publishing his own famous wave equation. This equation yields a wide class of solutions formulated in any geometry, be it a Cartesian coordinate system, cylindrical, spherical, the toroidal coordinate system, and other.

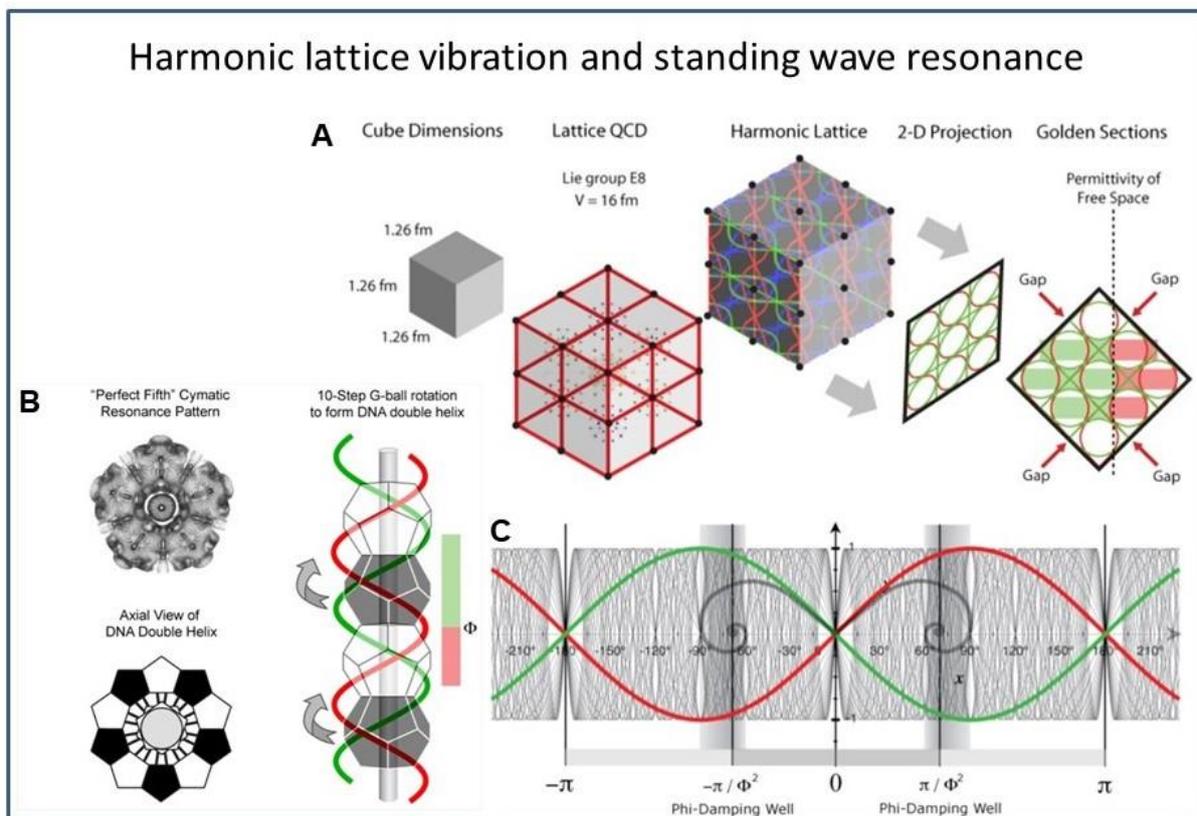
Spherical harmonics differ from standing wave patterns because they describe a wider assortment of shapes like spheres, barbells, and so forth, that offer a richer description of electron behavior. Superstring theory, a hypothetical attempt to unite the fundamental forces—the gravitational, electroweak and strong force, applies the idea of harmonics on a far smaller scale than atomic physics, on the order of the Planck length, about  $10^{-35}$  meters (compared to about  $10^{-10}$  meters for atoms). The theory replaces point particles with vibrating strands of energy. Various modes of vibration determine the particles' properties, explaining the diversity of the particle zoo of the standard model, through the complexity of the oscillations and the geometry of the higher-dimensional space in which they are embedded (**Geesink and Meijer, 2018c**). All this implies that harmonics is a fundamental feature of nature on many scales.

In *Music and the Making of Modern Science*, Peter **Pesic, (2014)**, even claims that the art of harmonics shaped today's science in line with the science philosophical study on Science and Art (**Meijer, 2018**). Music resonates, it pulses, it leaps into our psyches. From a wide array of scientific research in music cognition, neurophysiology, genetics, acoustics, quantum physics and own calculations and experiments, he developed a set of principles and mathematical models to explain how we recognize and enjoy music. The theory proposes that life grows as a balance between resonance and damping, just like a vibrating string and that music perception is a built-in pattern matching between the harmonic geometry of sound and identical structures in the ear and brain. It is from this organic pattern matching process that the musical qualities of consonance, dissonance, tension and resolution can be defined mathematically and then visualized geometrically as crystalline and quasi-crystalline structures, (see also **Lefferts, 2019**).

In quantum mechanics and quantum field theory, the ability of energy to travel freely through space is referred to as vacuum permittivity or the permittivity of free space and defined by the "electric constant" (see **Fig. 12**). Each point (or quark) in the lattice requires a little extra space in order to oscillate and resonate, which Phi provides in the phase-conjugate spacing of sinusoidal waves. Thus, the more harmonic and in-phase the vibration, the more the so-called Phi gap comes into play (see **Fig.12. C**) and the more stable and coherent music and matter become. **Leffert, 2019** made clear that the aspect of damping creates the stillness that is required to really discern the individual tones within an octave, and that the perception of music rather becomes manifest *between* the notes. The study of these in-phase states is thus based on quantum coherence and this aspect is fully expressed in theoretical science behind such phenomena as lasers, superconductivity and superfluidity.

In general, the *Harmonic Interference Theory of Merick, (2009, 2010)*, offered a unified natural philosophy that merges ancient Pythagorean harmonic science with the quantum holographic model of Bohmian physics and holonomic brain theory. One of the key principles of Harmonic Interference Theory is the idea that coherent wave interference of any kind is recursive in space and time, nesting the same pattern inside itself synchronously in order to maintain coherence. The colors used in the various harmonic models are based on the simple idea that the visible color spectrum represents an octave frequency range just like a musical octave. Just as a musical octave is a frequency doubling of  $x$  to  $2x$ , such as A-440 Hz to A-880 Hz, the color octave is also a frequency doubling from 370 THz to 740 THz. As a result, the Newton 12-step color wheel may be assigned as isomorphic spectral proportions to each of the tones in a musical octave using the Harmonic Center (D in the key of C) as a polar axis. Harmonic Interference Theory indeed proposes that it is the flow of energy across these two "Phi-damping locations" that accounts for perceived qualities in music, such as consonance, dissonance, tension and resolution (**Fig. 12**).

But what has music to do with brain function? Modern scanning studies have revealed a major influence of musical sound on brain activity and particularly in overall brain binding and connectivity. In this musical framework, it is of great interest that music is increasingly used in therapy of brain disorders and cognition studies. Music engages much of the brain and coordinates a wide range of processing mechanisms. This naturally invites consideration of how music processing in the brain might relate to other complex dynamical abilities.



**Figure 12.** *A: Permittivity of free space as a function of the golden ratio. B: DNA double helix modeled as G- ball dodecahedron resonating up around a central axis. C: Harmonic standing wave sharing energy inside Phi-damping tat provides the very separation of notes.*

**Sanya et al, (2016)**, stated: the tremendous ability that music has to affect and manipulate emotions and the brain is undeniable, and yet largely inexplicable. The study of music cognition is drawing an increasing amount of research interest. Like language, music is a human universal, involving perceptual discrete elements organized into hierarchically structured sequences. Music can thus provide the study of brain mechanisms, underlying complex sound processing, and also can provide novel insights into the functional and neural architecture of brain functions. The change in the structure and form of music does clearly bring a change in the neural dynamics, inviting studies on correlation of cognitive processes and a spectrum of musical modalities.

In relation to consciousness, **Perlovsky (2009)** made a very interesting analysis of its relation with musical emotions, suggesting an evolutionary split in proto-humans into one of language, offering the potential for *differentiation*, with an implicit loss of wholeness of the primordial unity of the psyche and another of music as a compensation for this. Music is rather directed at increasing the sense of communication-*shared intentionality* and *synthesis* in order to reconcile these cultural aspects in a new balance. Music is therefore seen as the most mysterious ability of the human soul that brings emotions from the unconscious to the conscious experience, restoring the deeper meaning of knowledge as an inborn instinct of harmony that, interestingly, is already manifest in babies beyond 4 months.

Of note, music is seen now as an important instrument in rehabilitation of disorders of consciousness, (for example Alzheimer's) and is likely associated with neuroplasticity. In this respect, significant effects of personally liked music on the brain level of certain neurotrophic factors, as well as on dopamine release and reward circuitry including endorphins, have been reported (**Kotchoubey et al, 2015.**) . It is of great interest that recently striking results were reported on the treatment of Alzheimer model in mice showing a clear reduction in amyloid plaques and improved cognitive performance, especially following a combination of visual (photonic) and 40 Hz acoustic brain stimulation. In this study the mice were treated with trains of tones repeating at various frequencies for one hour per day during seven days, (**Martorell et al, 2019**), demonstrating the potential healing effect of such therapeutic music guided approaches that may have a toroidal geometric background.

According to **Koelsch, (2009)**, a number of studies demonstrated that music listening, (and even more so music production), activates a multitude of brain structures involved in cognitive, sensorimotor, and emotional processing. It is likely that the engagement of these processes by music can have beneficial effects on the psychological and physiological health of individuals. In addition, neuroscientific studies using music in order to investigate emotion, and social cognition are reviewed, including illustrations of the relevance of these domains for music therapy

It has been proposed by others (**Lehar, 2003 2008**) that global (non-local) standing wave patterns in the brain exhibit a top-down operating *harmonic resonance* property of neuro-computation, that encodes complex spatial patterns in the brain and induces the synchronicity of neuronal networks required for conscious perception. This author illustrated this with the earlier mentioned geometric patterns of Chladny, like some of us did also more recently (**Meijer and Geesink, 2016**). However, no distinct frequency band pattern was identified in Lehar's studies. As treated before, we have shown that these patterns may be linked with solitonic wave resonances, according to a sequence of coherent EMF frequencies, suggesting a sort of harmonic-like kaleidoscope (**Meijer and Geesink, 2016, 2017**). Many examples of distinct EM frequency bands of brain cells, neurons and different glands have been identified (see **Persinger, 2016; Hartwich, 2009; Gramowski et al., 2015**), that largely resemble some of the individual eigen frequencies of the geometric/acoustic pattern revealed in our

studies. This supports the notion that communication of life information through coherent EM radiation is a widely spread phenomenon and that this aspect deserves further detailed investigation, (see further **section 7**).

We propose, therefore, that the pro-life EM frequency bands, identified in our studies may literally act in concert as “tonal octave-based symphony” to provide living systems, including the brain, with information embedded in such harmonic-like resonance patterns (see also **Attasoy et al, 2018**, as discussed later). Such “tonal” projections, that in a global manner, may organize synchronicity, both spatially and temporally in essential organs in the body (heart and brain). This “tuning” of life processes may originate from the proposed supervening resonance field, that in the brain imposes a coherent vibrating 3-D imprint in the cortical region, producing an *integral* modality of consciousness (**Meijer and Geesink, 2017, 2018a**).

It is of major importance that recently a brain model was proposed on the basis of a fractal information theory, derived from a geometric musical language that enables the brain to perform intelligent hypercomputing (**Agrawal et al, 2018**), and that this aspect has also been approached earlier by toroidal computing ( **Purwins, 2007; Van De Bogart and Forshaw, 2015, Meijer and Geesink, 2016, Tozzi and Peters, 2016, 2017**). Interestingly, and in accordance with our concept, the group of Bandyopadhyay (**Agrawal et al., 2018, Sahu et al., 2013, 2015, Hunt, 2019**) found evidence for firing *below the synaptic threshold* in EMF guided information processing in the brain. The particular oscillatory activities are supposed to be generated not only in microtubuli but also in many other protein complexes in the cell, that is, in a fractal setting that is expressed in circular and periodic modes in 12 fractal memory layers. This on the basis of 3-D resonance chains that also contain un-occupied elements that can be filled up by electromagnetic oscillator activity to produce proper information processing in the required integrated time cycles (resembling the concepts for superconductors in **section 2.5**). In the brain they identified 350 different classes of cavities in the nested (fractal) 12 layers and described each *cavity resonator as an octave musical flute* that together with silence periods collectively generates the known brain rhythms. Their fundamental basis is fractally organized, geometric information that finally become expressed the EEG. They identified 12 discrete resonance frequencies, among others with a solitonic (quasi-wave-particle) frequencies, very much resembling the mathematics of our GM-scale EMF pattern, that are integrated with many other factors in so called “*fractal frequency wheels*”. As mentioned above, we prefer to see the periodic circular/spiral energy trafficking in brain housed in nested toroidal geometry, in which each oscillation returns to itself in a self-referential manner, explaining the aspect of self-consciousness. Of note Bandyopadhyay et al., mentioned two types of memory loops they could not physically define, called by them “hyperspace memory” and “assembly of reality sphere”, that we may have defined in our present work on an event horizon memory workspace (see **section 5.7**).

In an interesting analysis of the holomorphic work of Penrose, **Grygiel (2018)** asked the question if the famous scientist should be qualified as a Platonist or as a complex Pythagorean. As to the harmony with nature, Penrose shows that the complex structures do indeed seem to accord in an exceptional way with the regularities according to which the Universe operates. This situation can be easily mapped on a *Riemann sphere* which represents all possible states of the particle (**Penrose, 2005**) and allows the use of complex or imaginary numbers. Yet, he maintains that the underlying mathematics pertains only to patterns of regularities observed in nature and not to its underlying ontology: mathematics is not the fabric that nature is made of as opposed to the conjectures of **Tegmark (2016)**.

So, what can we learn from the role of a potential *musical master-code* that likely operates scale invariant in the Universe? In our first papers on the generalized music principle and phonon-guided biology (**Geesink and Meijer, 2016a, Meijer and Geesink, 2016**), we suggested that “electromagnetically seen, we may be living in a “diluted plasma” with natural coherent quantum resonances, (see also **Van de Bogart, 2019**). Now we indeed see the growing importance of *acoustic cosmology* (**Handler, 2012; Stark, 2017**) that is manifest on the macro-scaled in a plasma universe (**Peratt, 2013**). On the micro-scale there is rising interest in distinct musical pattern steering on the level of whole organisms and cells (**Meijer and Geesink, 2019b**), in components of cells such as microtubuli in the group of Anirban Bandyopadhyay (see **Agrawal et al, 2016, 2017; Sahu et al. 2013, 2015**); DNA (**Savelyev, 2019a, 2019b**), Pi-electrons of lipids (**Crawford et al., 2018** and also the sound tapestry of single proteins and their networks studied in the MIT group of Buegler (**Giesa et al, 2011, Qin and Buegler, 2019**). All this, points at a resonant vibrational matrix that guides life and the entire nature, using a distinct musical code (**Meijer and Geesink, 2019b**). This also with regard to brain dynamics, as discussed in the present paper, for which even a novel brain ontology of *neural resonance and acoustics* was earlier proposed (**Johnson, 2009**).

### 5.11. Universal/Cosmic Consciousness and Brain Function

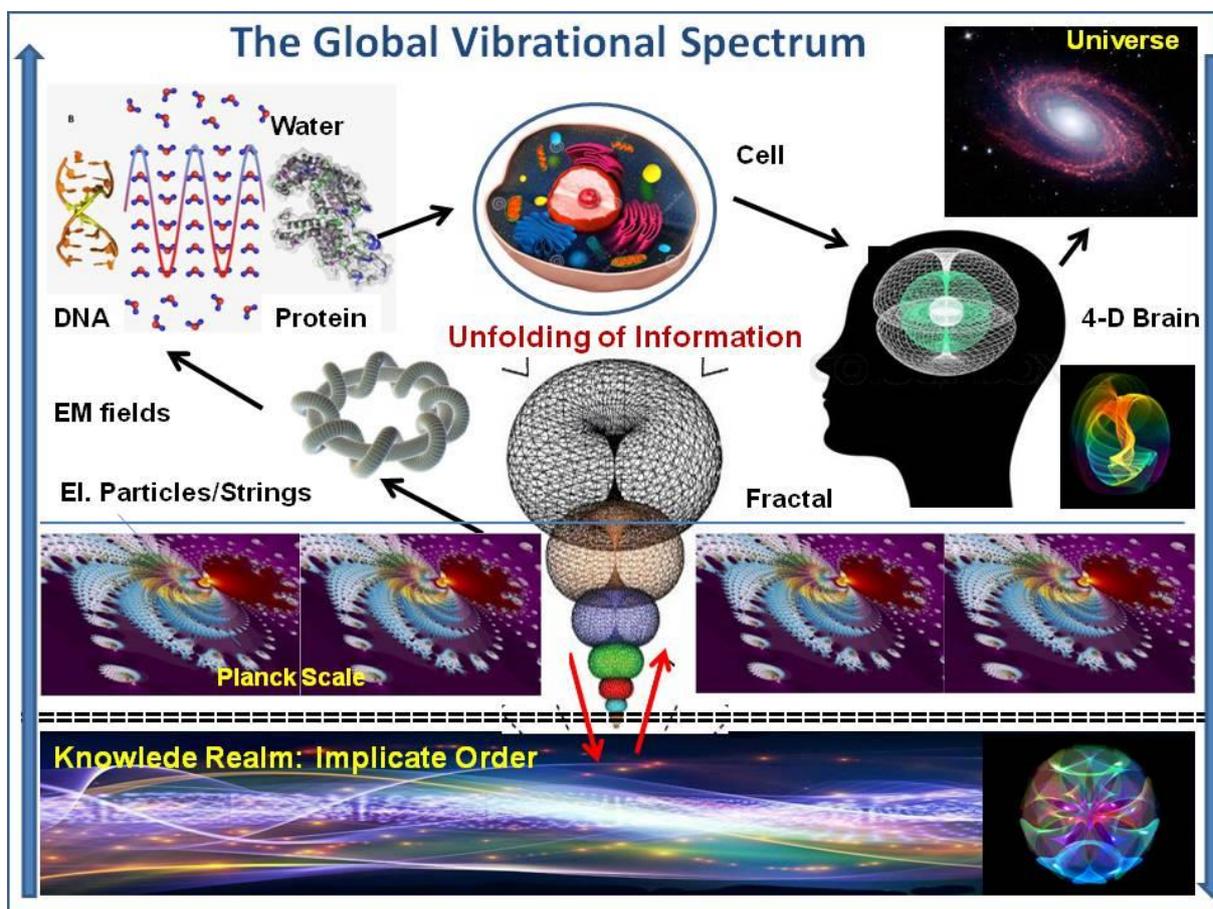
The presence of a “steering” functional mind field may provide an interpretation framework for phenomena that still seem to escape current scientific verification. A most important aspect is the, often mentioned, modality of Universal consciousness also called Cosmic Consciousness. This concept, that information can take a universal character and that all information is stored in a general knowledge field or universal consciousness, can be treated from a number of backgrounds and perspectives (reviewed recently by **Meijer, 2018**). As mentioned before, the concept is well known from the work of **David Bohm (1980, 1987)**, who coined the term implicate order and **Erwin Laszlo, (2007)**, who introduced the so-called Akashi field concept. The latter author particularly linked his concept with the physics of the zero-point energy field (ZPE) that, as previously mentioned, was later also applied in stochastic electrodynamic models for consciousness by **Keppler, 2012; Caligiuri, 2015; De la Pena, 1994; Kastrup, 2016, 2017**.

Such an all-pervading cosmic field can in principle exchange information with the supposed 3-D and 4-D workspaces associated with the brain (see **Fig.13**). An important study from Princeton showed that two, and possibly more, brains can become interconnected, looking at the brain f-MRI scans of speaker and listener. It was shown that the brain activity patterns of such a communicating couple are clearly correlated in a sort of wave resonance, mirroring, effect (**Hasson et al, 2012; Wackerman et al, 2003; Radin, 2004; Richards et al, 2005; Standish et al, 2004; Pizzi et al, 2004**). This study also invites further investigation into mechanisms of telepathy and so-called synchronicity (**Schwartz et al, 2005; Jahn and Dunne, 2004; Grof, 1987; Rousseau, 2011**).

**Hardy (2016)**, takes a space-time approach by positioning individual consciousness and the Self in a *hyper-dimension* in which death is just the severing of the link between this domain and the brain/body, leading to an independent holographic semantic field on a personal basis. This aspect was further worked out recently by **Meijer, 2019b**. The latter phenomenon resembles the proposal of **Irwin, (2014)**, seeing consciousness as a quantized space-time language that can be described by quasicrystal mathematics of the E8 geometry. It was also suggested that self-consciousness could continue outside the body but remains at the level of Planck-scale geometry, as related to generation of biophotons in which visual imageries are coupled to a long-term visual memory. This is supported by a strong indication that an NDE is driven by visual processes (**Bókkon et al, 2013**). In more general

terms, the aspect of non-material mental aspects of consciousness has been thoroughly pursued from neurological (Nagel, 2012), biophysical (Keppler, 2016), philosophical (Kadrop, 2016), quantum-physical (Henry, 2005) and evolutionary viewpoints (Grandpierre, 2014).

As mentioned above, Penrose, (1989), proposed that spin networks could be fundamental in the description of space-time, that is, in a background (string)- lacking manner, (see for the latter also Rovelli, 1996 and Smolin, 2004). In the brain, spin-networks were pictured as electron-unpaired electron spins that represent pixels, collectively forming a “mind screen” that is known to be highly sensitive to fluctuating internal magnetic fields and action potentials. Such perturbations were considered to modulate neural dynamics, but also could enhance synchronization and stochastic resonance as have been noticed in brain (Hu and Wu, 2004). The particular spin physics, bridges classical neural activity, serving as input via the magnetic influences on biochemical processing.



**Figure 13:** The flow of information in the whole universe from micro- to macro-levels (bottom to top) conceived as a nested toroidal operation that is fractal and scale-invariant and is initiated in a knowledge realm underlying the known wormhole matrix (quantum foam) at the Planck scale. Supposed quantized string activities produce elementary particles, atoms, molecules and life systems. The latter contain dedicated holographic memory spaces at the cellular and organ level. The human brain integrates, internally and externally, guided conscious states. Further fractal and self-similar properties in a quantum fluid universe provide the architecture of cosmic macro-structures.

Spin network dynamics may enable a quantum decoherence-resistant entangled modality of wave collapse since, through tunneling, they are rather insulated from the environment in decoherence-free

subspaces, while repeated attention/intention (Zeno effect, **see Stapp, 2012**), may help in promoting coherent quantum states (**Hu and Wu, 2004**).

Finally, we want to emphasize again that general ordering of the functional architecture of cells is obviously not sufficient to explain the fine tuning of life: clearly, deeper, more subtle, levels of dynamic organization are required. It was recently pointed out by **Görnitz (2016)**, that we do know very little of the fabric of reality from the size of the electron down to the Planck scales, and that it is a *misunderstanding that going smaller makes understanding more simple*. This is also true for explaining life: **Grandpierre (2011)**, postulated that “DNA works with the help of a factor that is utterly beyond DNA or any other material life system physical capabilities. This something is immaterial yet effective and belongs to science. This is the first principle of biology that acts as a deeper

Intelligence of the “vacuum,” in the sense that it virtually maps all the possible histories, summarizes the results of this mapping on its own basis and then decides about the biological endpoint and from there, and finally “chooses” the optimum physically realizable path”. This may also account for the fact that intelligence is a highly convergent feature in different evolutionary lines of animals that may have highly different brain structures (see also **Seed et al, 2009; Horic et al, 2012; Roth, 2015**).

At the bottom micro-level, such an information flow may be initiated on the level of a string mediated collapse of the wave function (**Mavromatos and Nanopoulos, 1995**) and/or may operate through spin-dependent transformation of classical and quantum mechanical information, that may also be the basis for the so-called quantum potential or pilot waves of the implicate order proposed by **David Bohm (1987)**. The corresponding 4-dimensional space-time domain also introduces aspects of two-times physics, tensed and causal time.

*Conclusion:* In the present essay, it is considered that the brain and its mental aspects are somehow coupled to the universe, in its superfluid domains (**Fig.13**), meaning that apart from neurobiological QM processes, cosmological QM-ones also affect brain transitions and dynamics. A unified theory of mind and matter has been postulated earlier on the basis of *information*, viewed upon as the most fundamental element for the description of the fabric of reality (**Meijer, 2012, 2013 a, 2013b; Samal, 2001; Levin, 2011; Grandpierre et al. 1997, 2013; Carter, 2014**). On the basis of such an informational interaction, some aspects of cosmic physics, as for instance the second law of thermodynamics (the entropy law), might apply directly to the brain. In other words: life, with its potential energy and isoenergeticity as well as the ability to screen and collect useful information, does in a way counteract the destructive tendency of increased entropy and at the same time may employ (entropic) gravity mechanisms to materialize essential knowledge. Perhaps this bimodal modality has been foreseen by **Erwin Schrödinger (1986)**, as the potential contribution of quantum processes in creating mental dimension.

## **6. Potential Roles of EM Fields in Biological Evolution and First Life**

### **6.1 Introduction.**

The development of science is not a linear way of steady progression; it is more akin to a living organism and knows not only ebb and high tide, but also critical bifurcation points. These are points of major decisions in which current sciences separated from a part of previous achievements as they are no more in harmony with the newly chosen paradigm, (**Meijer, 2018**).

Since we still lack even a good and generally accepted definition of life, nor a comprehensive theory of the living process, the last decision within the true seekers in biological community centers around the

concept of biofields (**Preto, 2016, Tzambazakis, 2015, Cifra et al., 2010, Muehsam et al., 2014**) and a distinct cosmological context. Nowadays, the mystery of the origin of life is tightly connected with an increasing number of uncovered exo-planets that resemble the Earth: is there life anywhere else in cosmos? Life is understood and treated mostly as a molecular phenomenon, as the prevalent contemporary view holds. However, as estimated by the majority of contemporary scientists, life should be widespread in cosmos, though it may chemically differ from the Earth bound (DNA-RNA/proteins) life. Contemporary life, even in its simplest forms, exhibits high complexity and ordering. In terms of informational theory, it has a relatively high informational content that should be stably reproduced from generation to generation. The chemicals that could be reproduced in simple primeval Earth simulating conditions (like ammonium ion, formaldehyde, hydrogen etc.) still lack a clear, persuasive and stable scenario that would lead from them to the macromolecules like the ones presently contained in contemporary organisms (**Meijer and Geesink, 2018b, Meijer, 2012**).

As it was formulated by **Walker and Davies, 2013**, the starting point for the emergence of life should mean an establishment of causal powers from the side of organized information over molecules. Here information in living systems is not seen as coded in a straight line (as in DNA), but in a diffuse, quantum wave-like non-localized, way. In present concepts this dispersed, organized and operational (active) information only partially resides in the DNA, it is also widespread in the whole living state of the organism. It is well known that *Acetabularia mediterranea* can reproduce its cap even without the nucleus, therefore with no DNA (**Jerman, 2009a 2016, 2018**). Consequently, and in line with Walker and Davies, we may cease to understand organisms only as trivial duplicators with errors. On the contrary, they should be perceived as systems with organized information and a high degree of flexibility (variability). According to this advanced view of the life process whereby it may establish itself also through some strange organismic forms in larger cosmos, life can be defined as dynamic and highly organized information (**Meijer, 2012**). Therefore, in our attempts to understand the possible origin of life and its continuation, we should try to identify a vital factor that a) would have a high probability to play an important role in biological processes, b) could maintain a high level of orderliness even in highly diversified chemical systems (systems with no "memory" molecule or genetic code, c) would be able to increase its informational content (complexity) through time (evolution), d) would be capable of specific interactions with a wide range of molecules, with a capability to direct their transformations similar to catalysts, e) would be at least physically feasible, if not probable within a supposed conditions of the pre-biotic world.

In the sixties of the past century, the earlier mentioned British biophysicist Herbert Fröhlich found that due to a high electric membrane field the living state at the level of cells rests on rhythmic and coherent oscillations of polar (macro)molecules (called also polarons, (**Fröhlich, 1968**) and that these oscillations can bring higher orderliness even into the cellular biochemistry. Fröhlich's ideas were later elaborated by an Italian group of quantum physicists (**Del Giudice et al, 2005, Vitiello, 2001, Preparata, 1992**) on the level of quantum field theory. This theory, called also the theory of quantum bio-electrodynamics argues that life at the cellular level (biochemistry, molecular movements) is highly organized through coherent (laser like) electromagnetic (EM) field that can behave as manifest particles of a very small mass (**section 3.1 and 3.2**). If the frequency of a coherent EM domain resonantly matches a neighboring molecule, the latter is attracted to its outer surface and is oriented at the same time. The field is also important from the thermodynamic standpoint, namely the output energy of a chemical reaction is not dispersed since it continues travelling as a polarization wave, the so-called *soliton*. Hence, in an extended coherent region, i.e. the region that comprises many CDs and the space in between the diffusive, Brownian motion of molecules is replaced by a selective dynamic regime, where molecules recognize and interact with one another via *frequency matching*. Since the excitable

spectrum of a CD is very rich (**Del Giudice and Preparata, 1998**), a variety of extended domains can emerge that may assume fractal (nested) architecture, as analyzed by **Vitiello, 2001**.

Extended domains entail two important consequences, namely a defined size of the coherent system, and the appearance of geometrical shapes (**Del Giudice and Tedeschi, 2009**). To have a precise frequency matching, the relative positions of reacting molecules must assume a specific spatial configuration, corresponding to biological structures. Therefore, we may safely assume that taking into account primordial conditions of the Earth (not going into the origin of life elsewhere in cosmos), previously enumerated characteristics should not be uncommon, difficult or improbable to find. According to the here presented definition of life we may claim that such organized systems are not yet alive if they do not have a clear possibility (actually a stable trajectory in a complex evolutionary phase space) to evolve into something more complex. With no such possibility, even if highly organized through the coupling between coherent modes (field level) and chemistry (substance level), they would be similar to various autocatalytic cycles. Such tiny bodies in fact strongly resemble living organisms. Their multiplication would indicate that they do possess *active organized information* but do not possess the genetic apparatus distinctive for ordinary living beings and even viruses. Therefore, if we take into account the here offered definition of life that is bound to specifically organized information expressing itself through a close and mutual interplay of the coherent field and countless molecular interactions, we may assume that electromagnetic type of non-local quantum fields that are assumed to have been present from the start of the universe were instrumental in prebiotic processes and first life.

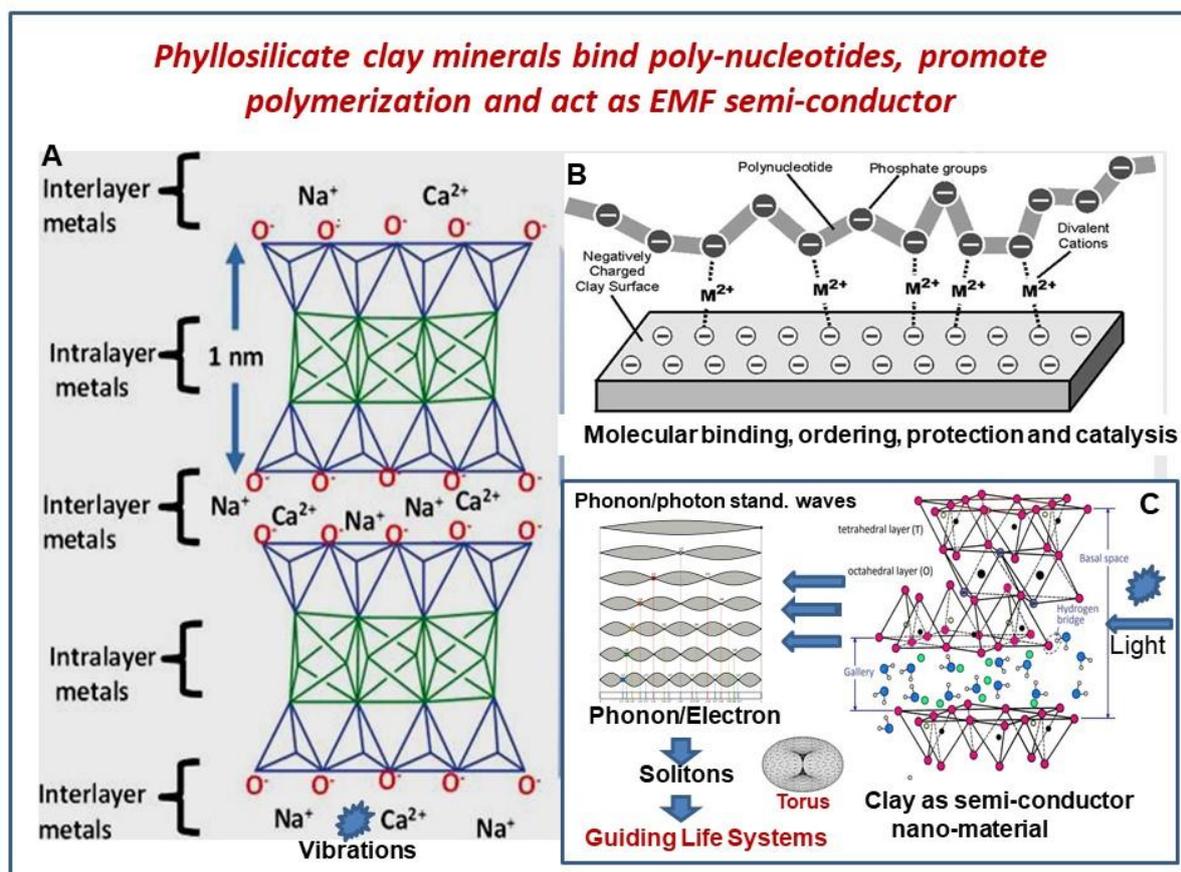
Nevertheless, the story of the origin of life, a tremendously organized and complex process amid a chaotic world of matter and energy, is still a mystery. Our present view on the origin of life does not disregard conventional chemical and physical aspects of life, it only tries to connect them onto a deeper whole by the integration of active organized information. One essential factor of the living process, a coherent field together with partially dynamically ordered water was presented **in section 3**. As a result, the order of coherent modes of pre-living water vesicles would function as a dispersed systemic memory, that would sustain organized information and would replace contemporary DNA or RNA. No genetic code would be needed – instead, the code of resonant matching between coherent field oscillations and molecular reactions would be in place. Only gradually and presumably long after the first organisms appeared, the natural selection together with laws of the state dynamics would result in the transference of the dispersed memory contained in coherent oscillations into the focused molecular one (based on DNA, RNA).

What all of this implies is that each living cell is radiating or is resonating in a biophoton field of coherent energy. If each cell is emitting such a field, then the whole living system is, in effect, a resonating field, being a ubiquitous nonlocal field. Moreover, since biophotons are the entities through which the living system communicates, there exists a near-instantaneous intercommunication throughout the organism. And this, claimed **Popp (1994, 2002)**, is the basis for coherent biological organization, referred to as quantum coherence. This discovery led Popp to state that the capacity for evolution rests not on aggressive struggle and rivalry, but on the capacity for communication and cooperation. In this sense the built-in capacity for species evolution is not based on an individual, but rather on living systems that are interlinked within a coherent whole: Living systems are thus neither only subjects, nor are they isolated objects, but simultaneously as subjects and objects function in a mutually communicating universe of meaning in a quantum domain (**Davies, 2014; Walker and Davies, 2013, Meijer and Geesink, 2018b**).

These relatively new developments in biophysics may imply that all biological organisms are constituted from a liquid crystalline medium, whereby body cells are involved in an instantaneous fractal communication via the emittance of biophotons. Furthermore, DNA itself may act as a liquid-crystal, lattice-type of gel-structure. This implies that all living biological organisms continuously emit light, although in an ultra-weak manner, which thereby forms a coherence field for life communication. (Bischof and Del Giudice, Preto, 2016; Chifra, 2016).

## 6.2 Creation of First Life and the Role of Phyllosilicates (Clay Materials)

We found previously that coherent natural and permanently operating wave pattern phenomena are present in typically selected clay minerals, that have semi-conductor-like properties (Geesink and Meijer, 2016; Meijer and Geesink, 2016 and Geesink and Meijer, 2017): identical EM field eigenvalues could be measured by Ir. J.H Geesink, The Netherlands (Fig. 14). Of note, these types of clay minerals are, apart from being present in the soil, also abundantly suspended in the universe, including the planet Earth (so called cosmic or extraterrestrial dust) and have been suggested to provide a semi-conductive medium that produces selective EM wave patterns following excitation by external energy sources.



**Figure 14.** Phyllosilicate clay mineral with stabilized ion/water clathrates. **A:** The metal ion-doped silicate structure exhibits platonic geometries (After G. Sposito). **B:** Surface structure of a clay mineral offers binding sites for negatively charged polynucleotides as assisted by positively charged metal ions. **C:** Clay a semiconductor: EMF wave function, guiding the ordering principle in life processes as an acoustic, standing wave, system, generated by transmitting exposed light to discrete EMF wave frequencies

It is of interest, that such silicates have been reported to be among candidates for the facilitation of oligo-nucleotide synthesis in the creation of first life in the biological evolution (**Geesink and Meijer, 2016; Meijer and Geesink, 2016, 2017; Melkikh and Meijer, 2018; Adamatzky, 2013; Hashizum, 2012**).

The selected silicates probably act as quantum replicators. They specifically emit EM radiation at GM-coherent frequencies in the surroundings of ordered water molecules. Therefore, such silicate quantum replicators may have been instrumental in the initiation of first replicating living cells at the edge of pre-biotic evolution (**Adamatzky, 2013; Hashizum, 2012, Grandpierre, 2014, Melkikh, 2016; Tranter, 1985; Walker and Davies, 2013**). We hold that the organization of precursor molecules for the first life principle molecules fits into a fixed coherent pattern of resonances, and can be described by the proposed semi-harmonic quantum wave equation. Preliminary evidence concerning the transition from inanimate matter to biological systems through the mediation of smectite clay minerals, indicate that this probably occurred through selection and protection and concentration of essential building blocks, in addition to the organization of chemical reactions of organic precursors, yielding the essential macromolecules of life that we know today.

Furthermore, quantum processes have probably played an essential role in facilitating the various steps that gave rise to first life and initiation of the first replicating cells, in which atomic resonance creates organic shapes and geometric folding of carbon containing molecules (**Davies, 2004; Walker and Daves, 2013; Grandpierre, 2014; Tranter, 1985**). This, should have paralleled the lattice type of organization of dipole water molecules. Together they form a harmonic-like lattice resembling fluid crystals in which life can be viewed as a crystallized form of quantum oscillations. This concept invites us to see the cosmos as a purpose-driven incubator for life. This entire process was also depicted as a kind of “biological music” (**see section 5.8**) originating from a pre-existing universal law intrinsic to nature, and conceptualized as a toroidal alternative to random self-organization (**Meijer and Geesink, 2018; Melkikh and Meijer, 2018**). Very likely, syntropic (i.e. neg-entropic) wave information from the zero-point energy field (**Irikura, 2007; Sarfatti, 2015; Setterfield, 2002**), selected in resonance with the *electrome* (**De Loof, 2016**) of the proto-cells played a crucial role in the morphogenesis and building up of functional biochemical networks during pre-biotic processes, (**Keppler, 2012, Sbitnev, 2016**).

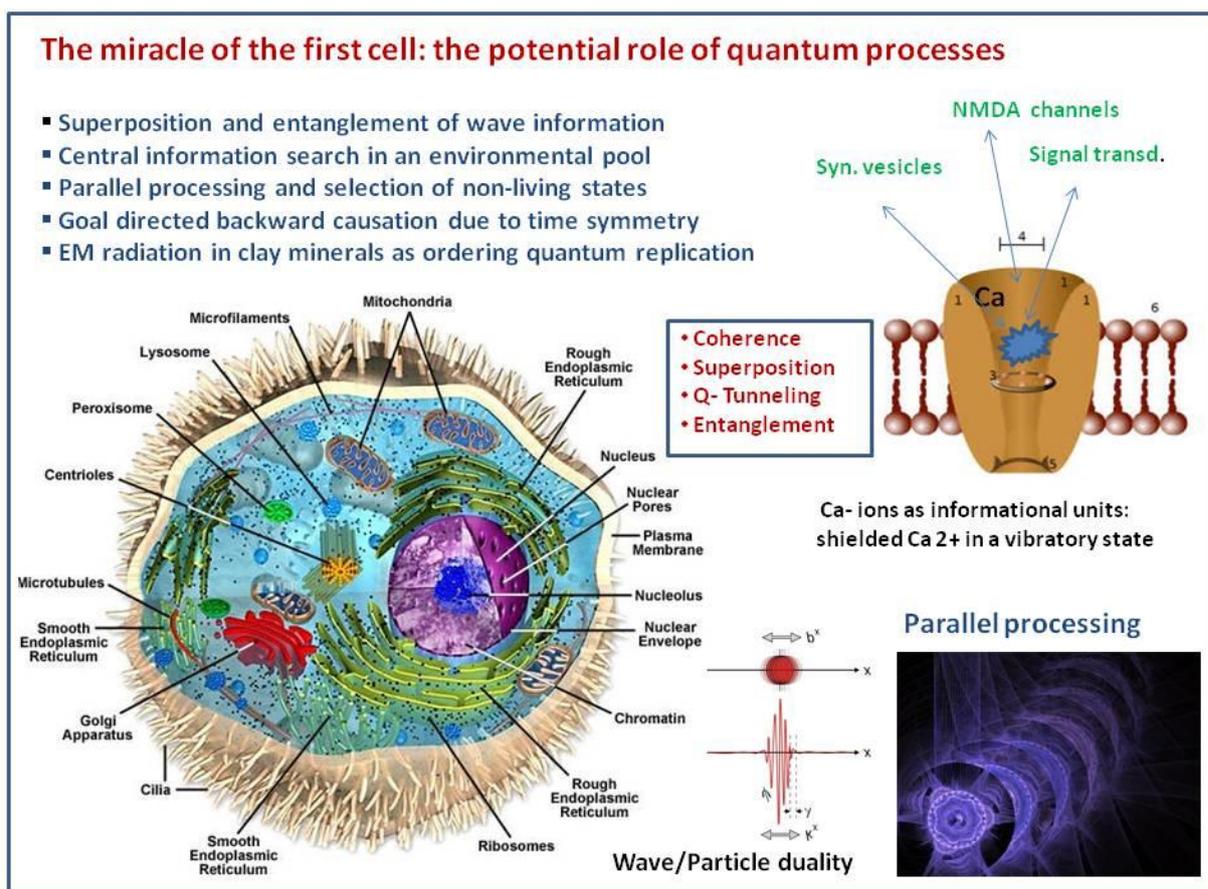
Conclusion: elements in the universe have seemingly assembled themselves in such a way that the organization of matter resulted in the ability to acquire sufficient life-sustaining information from the environment. Over time, highly complex neg-entropic structures arose that could collect, store, retrieve and communicate essential information to maintain stability and survivability. Such pattern recognition ability may have been directed by combinations of EM radiation frequencies through inducing morphic resonance with coherent vibrational elements (structured water, proteins, oligonucleotides) of proto-cells (**Meijer and Geesink, 2019b, 2018b, Melkikh and Meijer, 2018**). Here, the 3-D conformation of macromolecules is crucial in attaining a versatile functional state, as treated in the following.

### **6.3 Long Distance Guiding of Cellular Processes in Life**

According to **Wolynes (2015)**, the integral folding process includes random mutations, potential misfoldings/unfoldings, recombinations and selection by successful competition with less optimal protein species, in which the protein finally obtains sufficient stability in subsequent generations of cells. As such the proteins were seen by the author as non-linear elements in cellular networks that arise from a

sort of information spaces that, unfortunately, were not further defined. One could also question the supposed random character of this self-organizing process. In other words, how can the selection of non-functional precursors of the particular protein be envisioned? Moreover, by what physical mechanism is a specific function assigned to the particular protein? As argued by **Grandpierre (2001)**, life functions of proteins cannot arise by chance, they can only be assigned by their host cell, but such a cell cannot arise without these functions being already assigned and present. We propose therefore that a primordial biological principle (register of rules) was operating, which acts as a “recipe for life” (**Meijer, 2012**). This type of a-priory information must have preceded the development of first life and we postulate that all known force fields, that were present from the birth of the universe, should be taken into account (see more later). In addition, quantum processes have probably played an essential role in facilitating the various steps that gave rise to first life and initiation of the first replicating cells (**Walker and Davies, 2013, Meijer and Geesink, 2018b**).

**England et al (2008, 2015)**, derived a mathematical formula they believe is capable to explain the capacity for creating life conditions. The formula, based on established physics (the 2nd law of entropy), indicates that when a group of atoms is driven by an external source of energy (like the sun or chemical fuel) and surrounded by a heat bath (like the ocean or atmosphere), it will often gradually restructure itself in order to dissipate increasingly more energy.



**Figure 15.** Potential role for quantum processes in biological evolution (listed left above) and the initiation of first life, showing various essential processes. Inset on the right above depicts a Ca<sup>2+</sup>-ion in a decoherence protected vibratory quantum information state. Inset right below indicate the process of parallel processing of pre-biotic life information as enabled through environmental search of various quantum states.

This could mean that under certain conditions, matter inexorably acquires the key physical attribute associated with life. Consequently, according to this hypothesis, as particles in a system move around and interact, they will, through sheer chance, tend to adopt configurations in which the energy is spread out. Eventually, the system arrives at a state of maximum entropy called “thermodynamic equilibrium,” in which energy is uniformly distributed. It is known that the phenomenon of quantum coherence, assumed to be present in prebiotic systems, may enhance photosynthesis because it simultaneously excites two kernels in the system by the appearance of two interrelated quantum entangled excited states (**Tamuliset al, 2013; Tamulis, et al, 2014; Tamulis and Grigalavicius 2014**). England (**England et al, 2008, 2015**), stated that: “Livings are self-assembled and self-replicating wet and warm, stochastically moving, supramolecular systems where quantum entanglement can be continuously generated and destroyed by non-equilibrium effects in an environment where no static entanglement exists. Quantum entanglement involves the biomolecules inside one living or between other neighboring living entities”.

However, a number of fundamental questions can be raised with regards to the proposed mechanism of emergence of cellular life by England et al., especially with regard to the item of self-organization:

- The present authors maintain that such an emergent process will exhibit countless potential solutions of which the evolutionary time would be insufficient to make proper choices for the most optimal ones (**Melkikh and Meijer, 2018**).

- It speaks for itself that in this manner molecules could in principle be formed that are suicidal for the overall process, as it has already been demonstrated for Eigen’s autocatalytic hypercycles that would be sooner or later destroyed by parasitic autocatalytic (hyper)cycles (**Cronhjort et al., 1997**).

- The scheme of England does not take into account that a potential top-down information flux of future states can in principle operate since local quantum processes allow symmetrical time modalities. This item was touched upon also by Stuart Kauffman in his concept of adjacent possible (**Kauffman, 2000**).

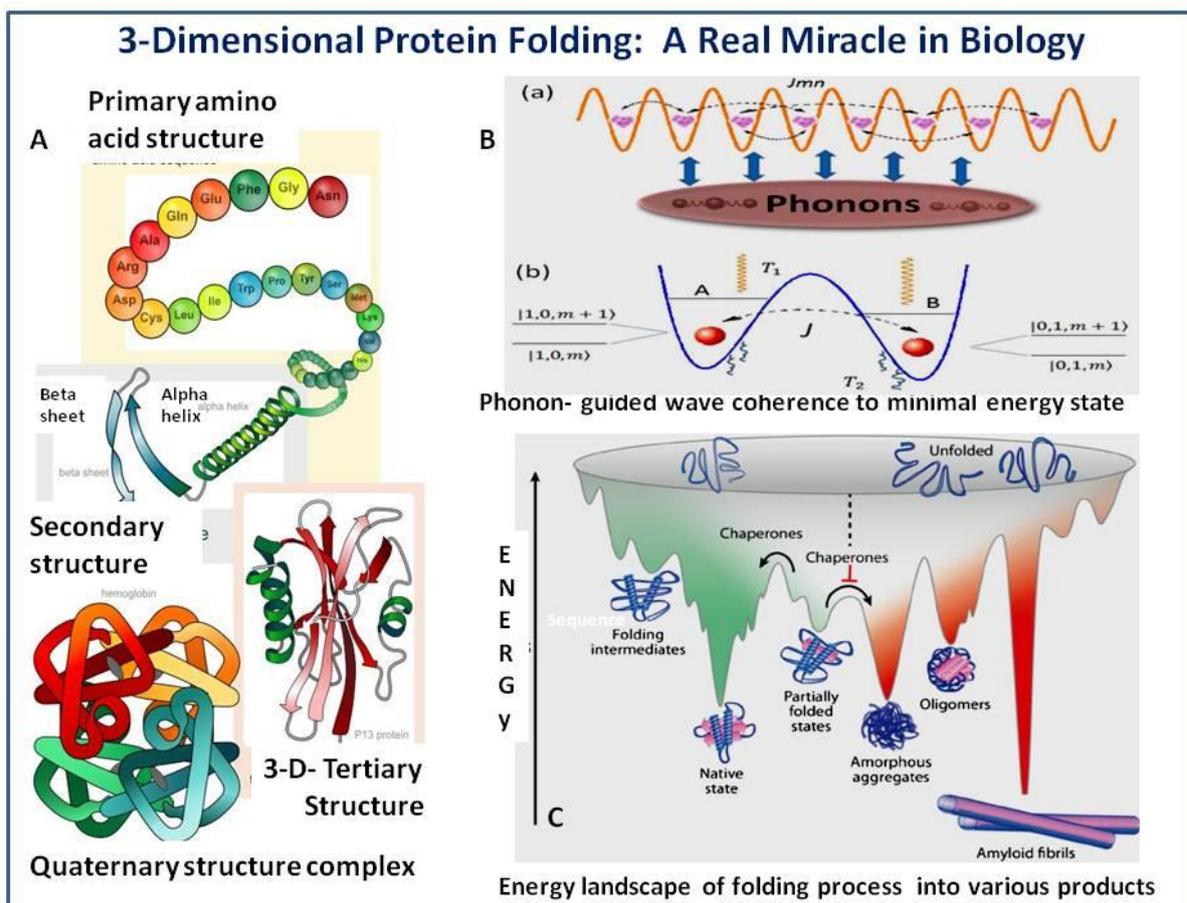
- We hold that *primordial information* is required, and assume it to be guided by long-distance discrete EMF frequencies as a form of *partially directed* evolution (**Meijer and Geesink, 2018b, 2019b, Melkikh and Meijer, 2018**)

#### **6.4 Biological Evolution Is a Partially Directed Process**

In the present paper, we assume a long-distance wave/particle influence on brain function in relation to consciousness. Such a long-range aspect was earlier described by us for a potential soliton-guided protein folding (**Melkikh and Meijer, 2018**). All this is based on the conjecture that a background field, such as a zero-point energy field or a superfluid quantum space (see **section 7**), plays a crucial guiding role regarding the biological macromolecules and their countless interactions within organisms. A part of this quantized vacuum field could be represented by the generalized music scale biophysical principle (**Meijer and Geesink, 2018b, 2019b**), that was revealed in both animate and non-animate systems (see **section 1**). How does the proposed directed evolution relate to human consciousness? In various papers (**Melkikh and Khrennikov, 2017; Melkikh and Mahecha, 2017; Melkikh, 2018; Melkikh, 2019**), it was shown that thinking (and thereby implicitly also

consciousness) is the natural product of a *partially directed* evolution of the universe and that, consequently, new knowledge should, at least partly, explain the already existing knowledge at a much deeper level. **Jerman et al. (1998; 2009 a, b, c; 2016)**; and **Gregorcic and Jerman, (2009)** strongly advocated the significance of a guiding biofield in biological evolution (see also **Tzambazakis, 2015**). Such a steering modality exhibits non-linear properties with feed-back amplification and refers to the earlier mentioned high frequency ( $10E11-10E12$ ), coherent Fröhlich field and the biophotonic field of Popp, that even can be mutually connected. This implies a conceptual extension of the Neo-Darwinian theory, in which environment is not merely considered as a contingently changing source of selective pressures, but rather as an integrative and formative system with its own dynamic physical laws.

To solve the problem of knowledge acquisition in life processes, the concept of *quantum metalanguage* was developed (**Melkikh et al., 2019**). Some operations within such a quantum metalanguage can be used to generate new languages from given languages, including replenishing them with new terms, symbols, etc. The physical basis for this is the non-local quantum field embedding the biologically important molecules. We hold that these molecules or rather their collective wave- fields are involved in the organization and work of innate programs, (including the related language programs).



**Figure 16.** (A): Protein folding from primary to quaternary structure; (B): Influence of phonons on wave coherence, leading to long-lived oscillations through energy dissipation (b) and protection to environmental noise (modified from Zhang and Wang, 2016) (C): Energy landscape with intramolecular (left) and intermolecular aspects (right), producing various end-products.

The superfluid quantum /ZPE space, as treated in the present paper, seems an excellent modality for defining the semantic basis for such an underlying metalanguage of nature.

As treated in the foregoing, quantum phenomena are likely at the heart of the brain function of humans and animals. In this respect, the involvement of quantum effects solved the so-called generalized Levinthal's paradox (**Melkikh, 2014b, Melkikh and Meijer, 2018**). In particular, in the work (**Melkikh, 2014b**), a quantum model of the interaction of biologically important molecules was constructed. According to this model, we can write the equations of the dynamics of biologically important molecules as follows:

$$i\hbar \frac{\partial \psi}{\partial t} = \hat{H}\psi + \varphi\psi \quad (1)$$

$$\frac{\partial \varphi}{\partial t} = g(\varphi, \psi) \quad (2)$$

Here  $\varphi$  is a multi-particle potential, responsible for the long-range interaction between biologically important molecules.

Based on this model, of **Melkikh (2019)**, the formation of synaptic connections between neurons can be modeled as follows:

$$\begin{aligned} \frac{\partial u(\xi_u)}{\partial t} &= \gamma f(u, v, \xi_u) + D_u \Delta u, \\ \frac{\partial v(\xi_v)}{\partial t} &= \gamma g(u, v, \xi_v) + D_v \Delta v, \\ \frac{\partial p_n(\xi_u)}{\partial t} &= \sum_m^{m_{\max}} W_{mn}(\xi_u) p_m(\xi_u) - \sum_m^{m_{\max}} W_{nm}(\xi_u) p_n(\xi_u), \\ \frac{\partial p_n(\xi_v)}{\partial t} &= \sum_m^{m_{\max}} W_{mn}(\xi_v) p_m(\xi_v) - \sum_m^{m_{\max}} W_{nm}(\xi_v) p_n(\xi_v). \end{aligned} \quad (3)$$

where the functions  $f(u, v)$  and  $g(u, v)$  are responsible for the kinetics of the reactions between substances  $u$  (activator) and  $v$  (inhibitor),  $D_i$  are the diffusion coefficients of substances, and  $\gamma$  is the scale factor,  $p_n$  – is the probability that system is in state  $n$ ,  $W_{mn}$  – is the frequency of transition from the state  $m$  to the state  $n$ . Variable  $\xi$  describes internal degrees of freedom of the reacting molecules and their spatial position. The essential point of the model is its non-Archimedeaness, which is expressed in violation of the principle of superposition for forces and potentials.

Variable  $\xi$  describes internal degrees of freedom of the reacting molecules and their spatial position. *Thus, in this system of equations,  $\varphi$ , in fact, represents a multi-particle potential, responsible for the long-range interaction between biologically important molecules.*

This implies that life function and thus the *quite discrete* reaction between these substances will depend on their 3-D conformations, as treated above. Neurons and neuronal networks, in this respect, are seen as a rather rough level of organization. Rather, non-local interactions between biologically important molecules play a crucial role of fine-tuning.

Yet, the system of equations-(3), explicitly, contains long-range interaction, that also could be instrumental in the formation of synaptic connections. The latter refers also to the formation of those new synaptic connections between neurons, that implicitly leads to a change in shape. We hold that this

formation process is not only influenced by the state of the neighboring neurons, but is also due to the implicit non-locality, and thus to entangled state with many other (more distant) brain neurons.

In this framework, we see the generalized process of *thinking (memorizing and perception, including pro-life decision making)*, as a natural stage in the directed evolution of life. Congenital programs of behavior, as well as other intrinsic properties of organisms, are seen therefore as a part of directed evolution (**Melkikh and Khrennikov, 2017**). Such an evolution, in our opinion, contains *a priori information* about the future states of the evolving system, similar to the already mentioned adjacent possible concept of **Kauffman, 2008, 2009**. At the same time, genetic events are, at least partly, controlled by long-range quantum forces, (**Melkikh and Krennikov, 2017; Melkikh and Mahecha, 2017**). We argue that, in a hidden form, (of force fields) this type of “thinking” exists at any stage of evolution. Such properties of living systems therefore should be implicit in the topological states of the universe, even before the big bang (also called the Big Bounce).

In the studies of **Melkikh, (2018)**, the hypothesis of a *directed evolution of life* in the Universe was put forward, which can be formulated in the form of the following provisions:

1. Before the Big Bounce (scattering process), the universe was in a pure quantum state. In this state, after scattering, the properties of the universe (field constants, particle masses, etc.) were encoded. This state itself arose by the mechanism of quantum phase transition.
2. At the initial stage of expansion, the universe was still in such a pure quantum state. As a result of an ongoing entropic decay (decoherence) it became hot. Yet, at the same time, some of its subsystems, weakly interacting with others, could even remain in a pure quantum state for a longer time.
3. Further expansion of the universe was somehow controlled by a gradual change in the parameters of dark energy and/or dark matter. The collective values of the constants and fields were expressed in macro-parameters determining the evolving architecture of the Universe and, for instance, allowed stars and galaxies to be formed later. Other parameters, related to force fields created the necessary conditions for the emergence of life at later stages.
4. At a certain stage, given the presence of all of these necessary conditions and following the appearance of atoms and molecules in certain complex systems, *quantum laws* governing the spatial structure and the evolution of replicators began to play an important role. Of note, these laws were also ultimately determined by the state of the Universe before the Big Bounce (by scattering). The presence of anti-matter was largely directed to a supposed adjacent universe (see **Boyle and Turok, 2018**).
5. Subsequently the proposed partially-directed evolution went in the direction of increasing the complexity of organisms, in relation to their ongoing adaptation to various environmental conditions. It should be realized therefore, that the particular laws of partially-directed evolution, were ultimately the result of the collective laws of physics as well as the initial conditions that characterized the initial forming of the Universe.

Notably, the here proposed model of a partially directed evolution of the universe, including the further emergence of life in it, demonstrates a striking similarity of the becoming of the universe with that of the evolution of living organisms. Because of this striking similarity, we may infer that our universe itself can be considered as a living modality. In this case, all existing lifeforms, with respect to the universe, can in fact be regarded as endo-symbionts of a cosmic super-organism.

## 7. Quantum Consciousness Is Steered by Hydrodynamic Mechanisms from a Superfluid Quantum Space

In the following section we will pay attention to question how our brain may communicate with cosmic fields such Zero-point energy/ Superfluid quantum space, as previously treated in **section 3.2**. We argue that consciousness is partly *received* from quantum wave information derived from these fields in a bi-directional interaction with our organism and here we address the potential physical mechanisms involved. This implies that we should identify the potential field receptive medium in and around brain tissue, according to quantum mechanical principles. This serves two major problems in current understanding in neurology and brain physiology: the origin of so-called qualia and the supposed broadcasting functions of neural networks that may explain the binding of distant brain nuclei (**Baars et al., 2013**). The assumed broadcasting mechanism should afford an instantaneous integration of the various sensory input that underlies our integral observation of the world around us. However, the physiological or biophysical process responsible for such broadcasting has not been identified until now, although a field type of mechanism seems plausible.

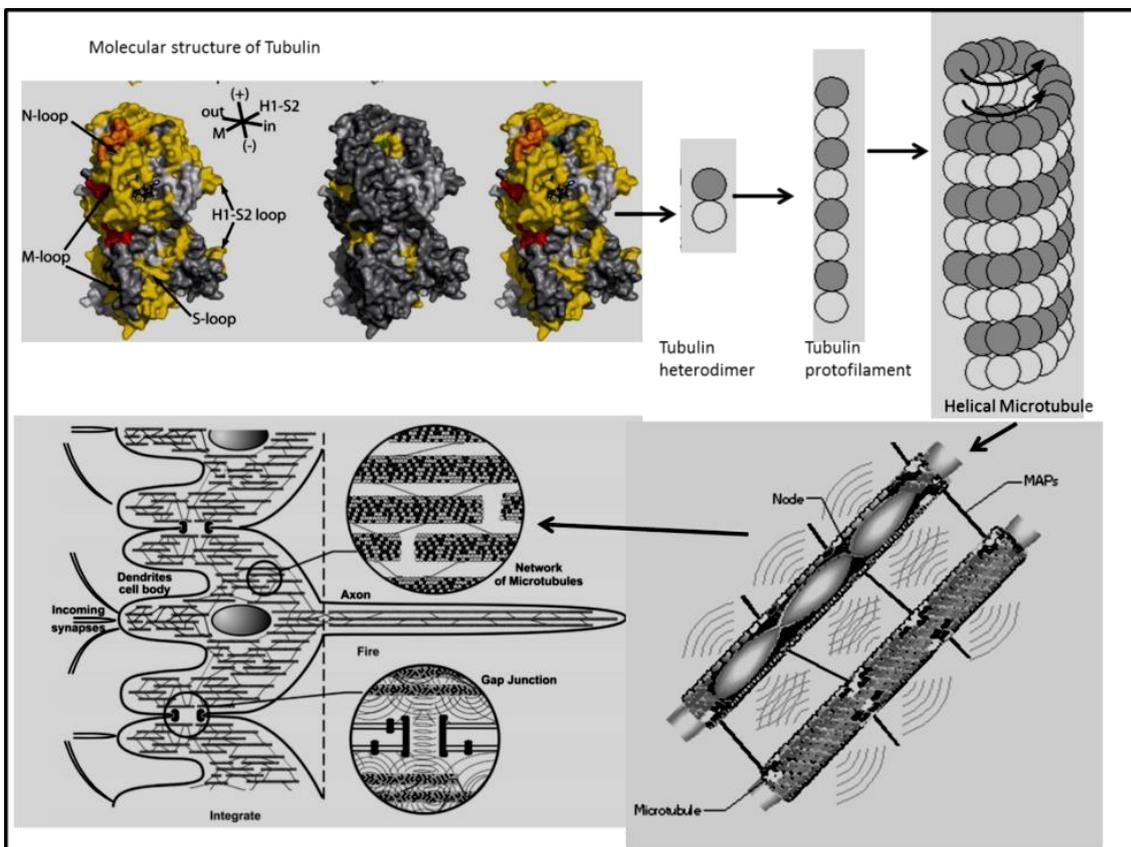
As mentioned earlier, we hypothesize the permanent involvement of photon- and phonon-dressed fermions such as electrons and protons (the quasi-particle soliton is one example). We hold that these are crucial in the function of our entire organism, with special reference to our brain (**Meijer and Geesink, 2016, 2017, 2019b**). The necessity to involve such a special mechanism has various backgrounds: a) to be able to deal with the ultra-rapid brain responses that are not compatible with the relatively slow synaptic process of neurotransmission (**Cacha and Poznanski, 2015**), b) in order to explain the abovementioned binding and synchronicity phenomena in brain function c) to understand the unexpected cognition capabilities of patients with severe brain damage (see **section 5.8**) and d) to address the presently unexplained subjective experiences in the category of Psi phenomena. All of these phenomena point to some kind of *ultra-rapid communication at a distance* in brain tissue and/or between different individuals. This may also be related to a non-local connection of humans to some kind of information domain that may explain phenomena such as precognition and near-death experiences.

*We stipulate that our hypothesis does not deny current models of neuronal transmission: it is rather meant as a complementary but essential aspect.* Alternatively, the structures that underlie neuronal function may be involved in brain function in another manner than the classical neural mechanisms generally assume. As mentioned before, **Georgiev and Glazebrook, 2018** presented an intriguing model of synaptic communication, in which quantum tunneling on the basis of solitonic interactions with SNARE protein complexes at synaptic vesicles is essential. The latter seems a modern version of the earlier presented model of **Beck and Eccles, 1998**. We hold that biological evolution may have selected all available biophysical processes for intra- and inter-cellular communication. In this respect, a “Two-Brain hypothesis” was postulated earlier by **Goodman et al, 2015**: postulating one electro-ionic modality related to the well-known neuro-humoral transmission and another that may be rather electromagnetic field- based The latter could be related to (bio)photon transmission that is *extrinsic* to classic neuronal brain circuitry. Implicit in the latter photon mechanism, is the particular speed of the process with inherent rates that are many orders of magnitudes higher than that of chemical neurotransmission. Also, it remains in principle possible that the quantum field type of transmission uses material elements that are also instrumental in classical circuitry. For example, it has been proposed that connective tissue/water assemblies may afford superconductive properties (**Ho, 2012**) and that myelin-based white matter in brain may function as optical wave guide (**Kumar et al, 2016**).

In any event, we should also take into account that the study of mental aspects of brain function and consciousness may require aspects of entanglement, non-locality and wave coherence, not offered by classical physics. Of note, such phenomena are experimentally demonstrated now in various cellular processes in Quantum Biology, and thus open the potential for top-down and retro-causal elements, as well as wave mediated action at a distance. They also invite a less reductionistic and more holistic top-down approach in the study of life in a cosmic context (Schwarz, 2019).

### 7.1 The Potential Role of Microtubules

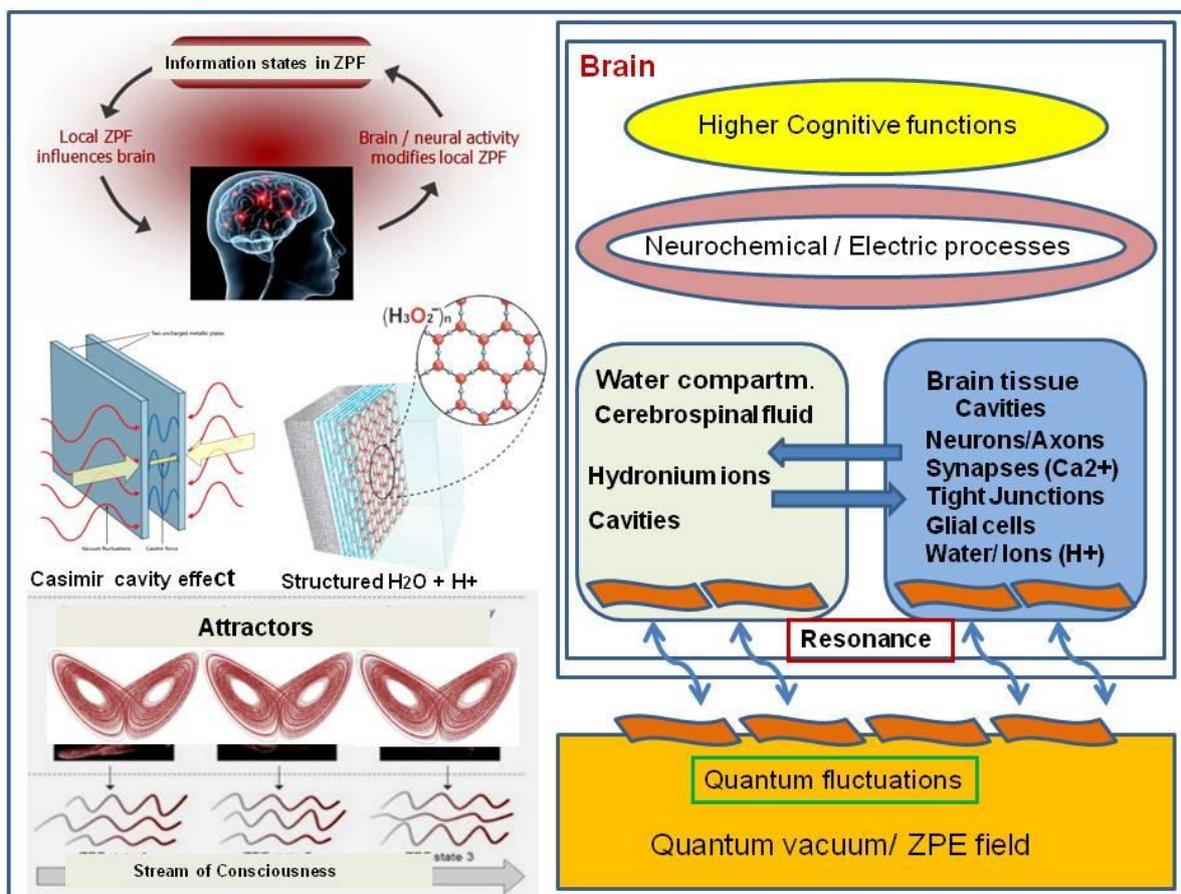
How consciousness arises from physical or material activity in the brain was, as earlier mentioned, framed as the hard problem in the study of consciousness (Chalmers, 1995, see also Nader, 2004). A radical solution involving quantum measurement as a process of consciousness was proposed by Stuart Hameroff, together with Roger Penrose. Their model (Orchestrated Objective Reduction: Orch OR (Hameroff and Penrose, 2014), suggests that quantum superposition and a form of quantum computation occur in microtubules, that form cylindrical protein lattices of the cell cytoskeleton within the brain's neurons. Of note, microtubules are actually present in all cell-types of our body and not only in brain. Here the microtubules play a role of detectors on which a collapse of wave functions is somehow executed. According to that theory, the latter involves crucial "fitting effects" related to quantum gravity on the Planck-scales of spacetime geometry. Their conjecture is that there is an orchestrated connection between wave collapse in the brain's biomolecular processes and the deepest basic structure of the Universe. We agree with this cosmic connectivity aspect, but the present theory of a zero-point guided EMF background field, based on a holographic memory workspace context, in principle, does not require wave collapse perse for creation of conscious moments.



**Figure 17.** An 'integrate-and-fire' brain neuron and parts of other such neurons are shown schematically with internal microtubules interconnected by microtubule-associated proteins. The figures are taken from (Hameroff, 1998).

As soon as the 'Orch OR' model was published, it was severely criticized by **Tegmark, (2000)**, whose primary remarks concerned the following egregious discrepancies: (a) the collapse of the wave function is much shorter than that of relevant dynamic timescales of neuron firings; and (b) wet warm brain, working at room temperature, cannot provide supporting quantum computations. Thermal noise of the brain would, in his opinion, completely exclude such delicate computations. This criticism, however, was later extensively and quite satisfactorily addressed (**Hagen et al, 2002**).

It is important to note that the microtubule hypothesis was experimentally supported by the innovative studies in Anirban Bandyopadhyay's group (see **Agrawal et al., 2017, 2018; Sahu et al., 2013, 2015**).



**Figure 18:** Model for wave-coherence-mediated conscious states: The brain water compartment functions as a receiver and conduit for discrete quantum wave frequencies via (i) excitation of hydronium ions in brain fluids that promote coherent domains in structured water (inset middle right) and other interacting cavity modalities or (ii) through cyclotron EM wave activity resulting in perturbation of delocalized ions such as  $Ca^{2+}$  in dedicated channel proteins, that through vibratory states can become quantum entangled. Both these events are leading to syntropic flow of information and increased functional binding and synchronization of neuronal centers that are known to promote conscious states. Information is, apart from the known senses, obtained by quantum resonance with the vacuum (zero-point energy field) and in the non-linear organized brain produced attractors that are the building blocks of conscious states (see **Fig 18**, left).

In the latter studies it was shown in life visualisations that self-assembly of of tubular proteins can be obtained under the influence of discrete EMF frequencies in the kHz, MHz and GHz ranges and that many of the registered resonance peaks of tubulins seem compatible with the earlier treated fractal GM-scale revealed by us (**Meijer and Geesink, 2019b**). It is of great interest that these authors found clear evidence for a fractal information theory-derived geometric musical language, that may guide brain-inspired hypercomputing as a basic phenomenon underlying consciousness, (see **section 5.10**), a concept that is very much in line with the concepts in of the present paper.

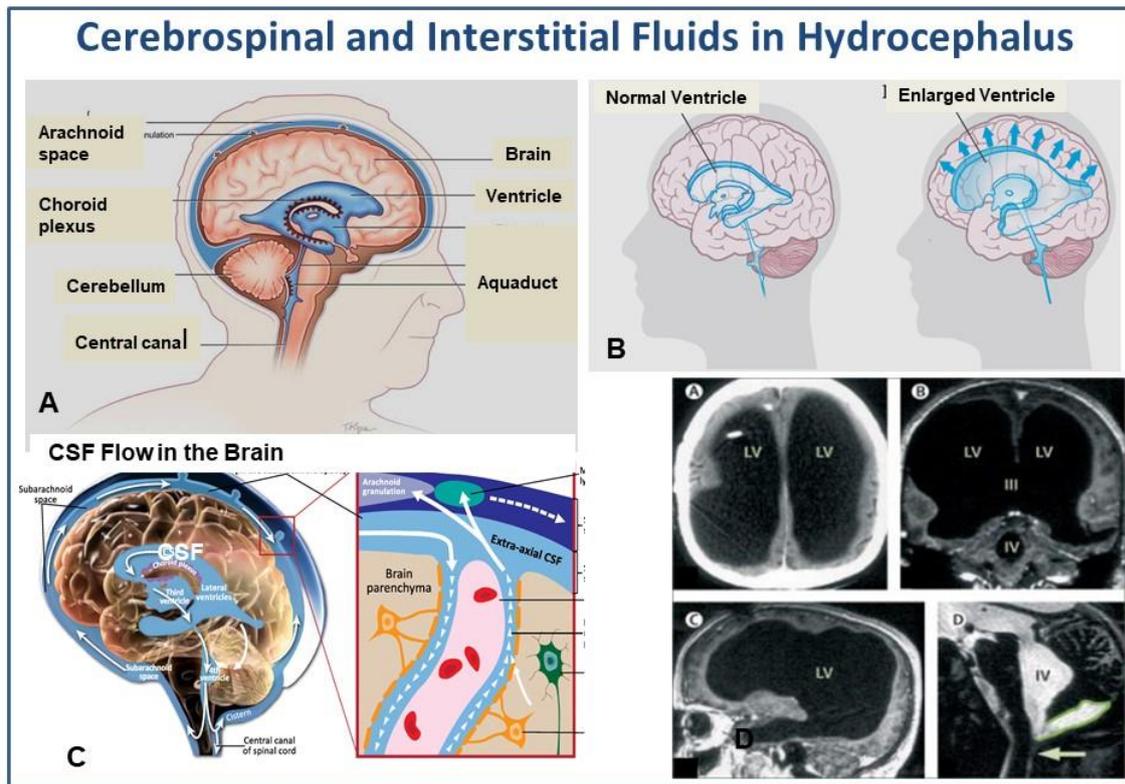
Taking into account the earlier mentioned criticisms, let us look at the Hameroff-Penrose theory from another side: the side mentioned by **Tuszynski, (2014)**. By inspecting the Hameroff-Penrose solution on the central role of oscillating microtubular proteins, an enormous matrix of oscillating tubular elements is occupying the whole brain, especially if other organelles such as mitochondria and nuclear DNA are involved at the same time. This entire vibratory machinery is embedded everywhere in the brain in the intracellular water. In the present study, however we also emphasize the importance of cerebral and interstitial fluids, that in concert with coherent water domains in the cells, could be involved in the guiding of consciousness originating from realms outside the brain. Interestingly, microtubuli in this context are not only 'scaffolding' instruments of cells but may also serve as warehouse for memory and memristors (**Chua, 1971 and 2011**), as instrumented by heavy ions, such as *calcium ions*. In the past, (see **Meijer and Raggett, 2015**), but also more recently, a number of attractive quantum brain models, have been proposed (see later, **table 3 and 4**), that are at least partially compatible with the present model (see **Fig. 18**, below).

## **7.2 Water, Water Configurations and the Wave Antenna Role of Protons**

Living brain is a biological organ which operates in a slightly salty liquid environment at room temperature. Most widespread chemical substance in the living body is liquid water (**Chaplin, 2016, Geesink Jerman and Meijer, 2019b**).

Water is the main liquid medium in the brain, where important events, related to consciousness occur. Although dendrites and axon terminals of neurons of the brain penetrate through all brain space densely, there are spaces relatively free of the nervous filaments. These spaces are ventricles of the brain filled by the cerebral liquid. As treated in **section 6.8**, in medical practice, there is a peculiar case in which a 44-year-old patient with postnatal hydrocephalus of an unknown cause (**Feuillet et al, 2007**). Magnetic resonance imaging (MRI) showed that his brain had hypertrophied brain ventricles, **Fig. 19 D**. The deficit of the filamentous organization demonstrates massive enlargement of the lateral, third, and fourth ventricles, with a very thin cortical mantle and a posterior fossa cyst. Surprisingly, however, this patient possesses quite normal social functions, and exhibited an intelligence quotient (IQ) of around 75. This example provides an indirect hint that the cerebral liquid, a slightly brackish water, may have a direct relationship to cognitive functions of the brain.

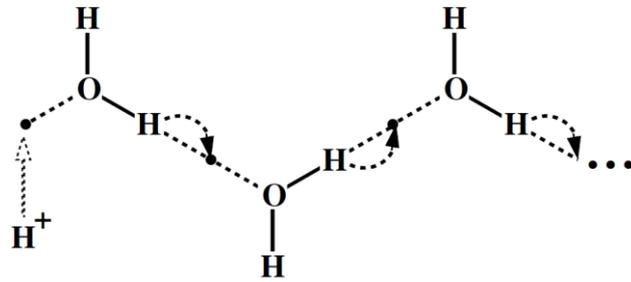
We assume that the proton plays an important role in the transport of subcritical information through the brain liquid. At room temperature, the liquid water consists of many fluctuating hydrogen-bonded clusters (**Chaplin, 2016**). The hydrogen bond is strong enough to maintain the coupling of atoms during some time under thermal fluctuations. As treated above, water can be depicted as consisting primarily of a mixture of clusters of water molecules with different degrees of hydrogen bonding in an equilibrium. Under thermal fluctuations, some hydrogen couplings are broken but other arise.



**Figure 19:** **A:** Cerebrospinal fluid compartments within and surrounding brain. **B:** Enlarged ventricle compresses brain tissue. **C:** Circulation of cerebrospinal fluid and contact with interstitial fluid. **D:** Massive ventricular enlargement, in a patient with normal social functioning: (A), (B), (C) MRI with gadolinium contrast at different cross-sections; (D) T2-weighted MRI. LV=lateral ventricle. III=third ventricle. IV=fourth ventricle. Arrow points to Magendie foramen. The posterior fossa cyst is outlined in (D). The figure is taken from **Feuillet et al, ( 2007)**, (see also **section 6.8**).

On average, the equilibrium distribution of different cluster sizes is maintained. **Fig.20**, illustrates the hydrogen-bonded chain mechanism (**DeCoursey, 2003**), called the Grotthuss mechanism, by means of which protons tunnel from one water molecule to the next via hydrogen bonding (**Chaplin, 2016; Hassanali et al, 2013**). Consciousness may arise through information transfer to this water from the ZPE-field. It can be shown that the thermal action parameter of a proton ( $b=k_B T \delta\tau$ ) is in the same order of magnitude as the Planck constant,  $h$ . (**Sbitnev 2016**). With  $k_B$ =Boltzmann constant= $1.38E-23$  J/K,  $T$ =temperature= $298$  K,  $\delta\tau$ =lifetime of a Hydronium ion =  $2E-13$  s,  $b=8.2E-34$  J.s vs  $h$ =Planck constant = $6.6 E-34$  J.s. This means, that the hydrogen ion may behave itself as a particle exchanging its energy permanently with the vacuum zero-point energy and not only with water. In other words, the hydrogen ion can act as an intermediary between the physical vacuum (i.e., the superfluid quantum space) and the water environment of the brain (**Sbitnev 2016**). The quantum mechanical zero-point energy is also mentioned by Beck and Eccles, in their article (**Beck and Eccles, 1992**) entitled "Quantum aspects of brain activity and the role of consciousness".

The mobility of the hydrogen ion in water leads to an average lifetime of  $2 \cdot 10^{-13}$  s (**Bell, 1959, 1973**). Hydrogen ion, that is proton, is considered here as a bit of information transmitting across the cerebral liquid of brain by the Grotthuss mechanism (**Chaplin, 2016**), (see **Fig. 19**).



**Figure 20:** Diagram illustrating the hydrogen-bonded chain mechanism for proton migration (Grotthuss mechanism) [6]: a proton enters the chain from the left side and then, as a result of the series of proton hops indicated by the arrows, a proton exits the chain on the right side. This chain represents a hydrogen-bonded 'water wire' (Chaplin, 2016).

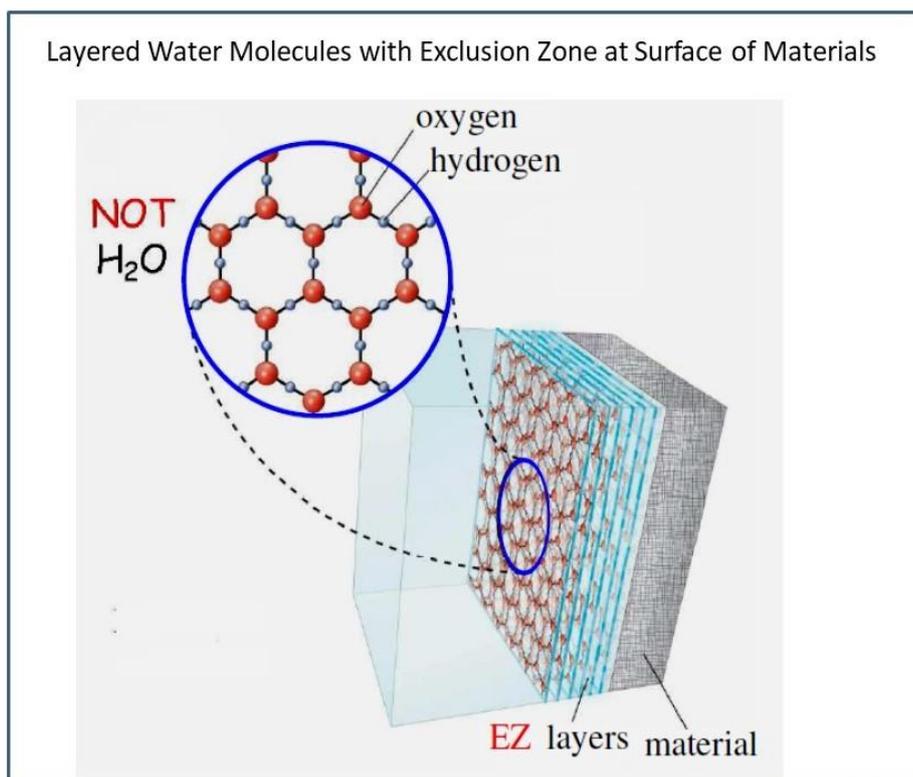
The mass of the quasi-particle, which they assumed in their article, was in the range of the mass of the hydrogen atom. Besides, they noted that the thermal energy  $k_B T$  of external environment ( $T = 298$  K) expressed in units of the electron-volt

$$E_s = k_B T / e \approx 26 \text{ mV}. \quad (4)$$

lies in the range of voltages where neurons operate. It means that thermal noise may have an impact on the electric activity of nerve cells. It is instructive, to draw attention in this article, to the time of the metastable instability of electronic transition,  $\tau$ , evaluated by the authors to be about  $10^{-13} - 10^{-14}$  s. Their estimation shows a relatively good agreement with the average lifetime of the hydrogen ion,  $\delta\tau = 2 \times 10^{-13}$  s.

In the transport of protons, the so-called exclusion zone (EZ) phase of water could play a significant role, **Fig. 4 and 21**. This special "fourth phase" of water arises near hydrophilic surfaces that abound in living tissues. Water molecules are ordered into hexagonal lattice, **Fig. 21**. and the exclusion zone (EZ) water (Pollack, 2013) expels any foreign inclusions so that EZ water molecules are more constrained ( see also **sections 2.3; 3.1 and 3.2**). An assembly of EZ water molecules is more stable. EZ has negative charge which is friendly to the resting membrane potential of neural cells. EZ absorbs light at the wavelength around 270 nm. These unique properties make the water a perfect conductor of the hydrogen ions through itself by the Grotthuss mechanism (Agnom, 1995, see **Fig. 20 and 22**) (Peng et al, 2015).

The hydronium ion can obtain a *soliton character*, since when moving along some surface it scrolls a mass of matter composed of a substrate along with it during this moving. In other words, the soliton can obtain a torque mode. If its core carries a charge, for example, positive charge of the hydrogen ion, then due to the torque it is covered by a coat of negative charges. In particular, due to this coat, the soliton lives longer than that with a naked charge. Surprisingly, excess protons can create their own pathways, 'water wires', before protons can migrate along (Peng et al, 2015).

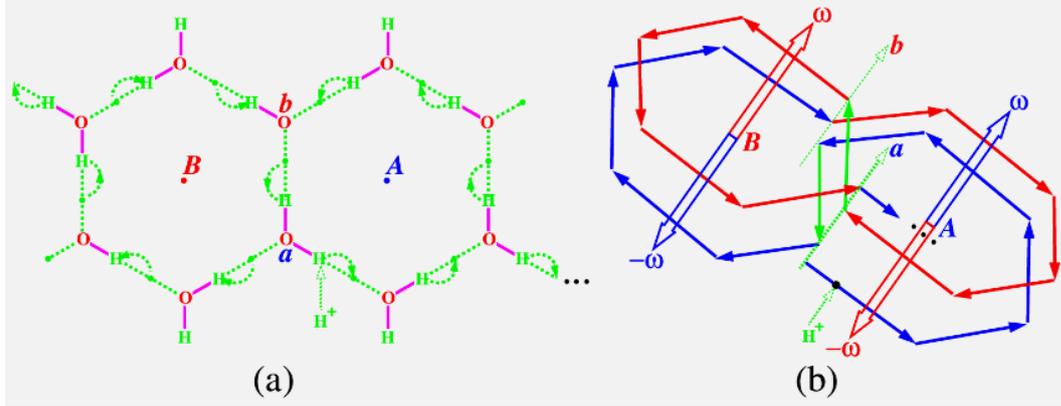


**Figure 21.** The "fourth phase of water" that can be found close to hydrophilic surface represents the ordering of the water molecules by a hexagonal lattice (Pollack, 2013).

Here we will try to understand what pathways are available for the moving protons. As was noted above, a main mechanism is the Grotthuss one that can be effective when water is in the "fourth phase" as expected to exist near the countless subcellular structures and the cellular membrane of neurons as well as in the brain fluid molecular material. In that case, water molecules are predominantly arranged according to the hexagonal symmetry, see **Fig. 22**. As shown in **Fig. 22(a)** the hexagonal symmetry can provide an eightfold path for the hydrogen ion entering on a hexagon assembled from water molecules. At the beginning, the hydrogen ion enters the right hexagon at the node *a* and hops along it around central point *A* clockwise. Then, upon reaching node *a*, the hydrogen ion begins to hop along the left hexagon around center point *B* in a counterclockwise manner. Upon reaching node *b*, the hydrogen ion re-enters the right hexagon, and so forth.

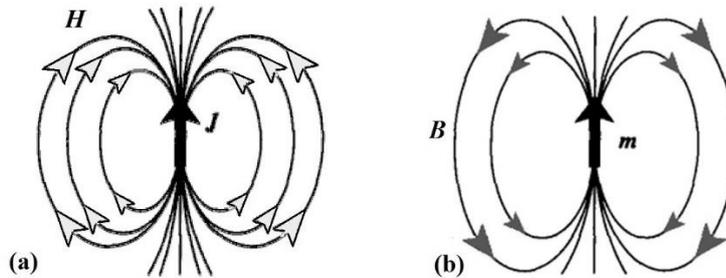
Each eightfold path, corresponds to two oppositely oriented vorticities  $\vec{\omega}$  that change the orientation after the completion of each cycle, see **Fig. 22(b)**. This illustration shows the following sequence of changing the vorticity sign. Initially, the hydrogen ion hops along the left hexagon in a clockwise manner. The vorticity  $\vec{\omega}$  is represented by the blue arrow. At the transition to the right hexagon at the node *a*, the hydrogen ion begins to hop in the counterclockwise way. The vorticity  $\vec{\omega}$  corresponding to this motion gets the opposite orientation (the same blue arrow oriented in the opposite direction). After completing the motion along the right hexagon, the hydrogen ion in node *b* enters again the left hexagon and begins to hop along it. The vorticity orientation remains (red arrow). After completing the motion on the left hexagon, the hydrogen ion, in node *a*, again passes to the right hexagon. The orientation of the vorticity changes sign to the opposite direction (the same red arrow oriented in the opposite direction).

As a result, we have the following pattern: (a) the eightfold path along EZ water molecules consist of oscillating dipoles in time due to the change of vorticity. (b) We note that arrows drawn on tips of the green dotted lines in **Fig. 22(b)** point to flow of time. (c) The dipoles exchange the orientations in the tact with oscillations that fluctuate in time. (d) If the EZ water contains many such eightfold paths working synchronously, then this EZ water plate can work as a multi-slot emitter-receiver of the electromagnetic field (multi-slot interferometer).



**Figure 22:** Hydrogen ion hopping along two EZ water hexagonal structures: (a) a general organization of EZ water consisting of two hexagons; (b) dynamics of the hydrogen ion hopping along two hexagons.

For comparison we show in **Fig. 23** the organization of the gravitomagnetic and magnetic fields taken from the book of Ignazio Ciufolini and John Archibald Wheeler entitled "gravitation and inertia" (**Ciufolini and Wheeler, 1995**). One can see that these fields have opposite orientations. The both fields are represented by almost identical equations, by the Maxwell equations. It turns, that the both fields give equivalent wave equations.



**Figure 23:** The directionalities of gravitomagnetism and magnetism compared and contrasted [51]: (a) the gravitomagnetic field  $\vec{H}$  in the weak field approximation,  $\vec{J}$  is the angular momentum of the central body; (b) the magnetic induction  $\vec{B}$  in the neighborhood of a magnetic dipole moment  $\vec{m}$ .

The wave equations for the gravitational-torsion field are shown in (**Sbitnev, 2019**). In particular, the wave equation for the weak torsion field  $\vec{\Omega}$  is as follows:

$$\frac{\partial^2}{c^2 \partial t^2} \vec{\Omega} - \nabla^2 \vec{\Omega} = -\frac{4\pi}{c} [\nabla \times \vec{\mathfrak{S}}] \quad (5)$$

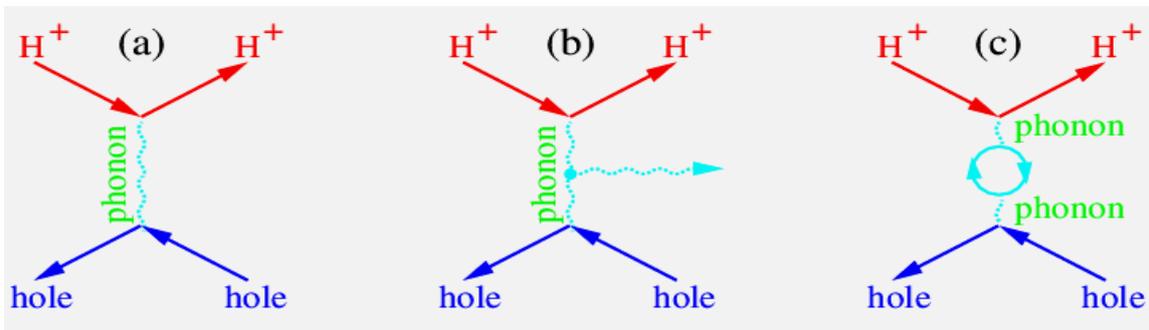
and the wave equation for the weak gravitational field  $\vec{\Xi}$  looks as follows

$$\frac{\partial^2 \vec{\Xi}}{c^2 \partial t^2} - \nabla^2 \vec{\Xi} = -4\pi \left( \nabla \rho + \frac{\partial}{c^2 \partial t} \vec{\mathfrak{S}} \right). \quad (6)$$

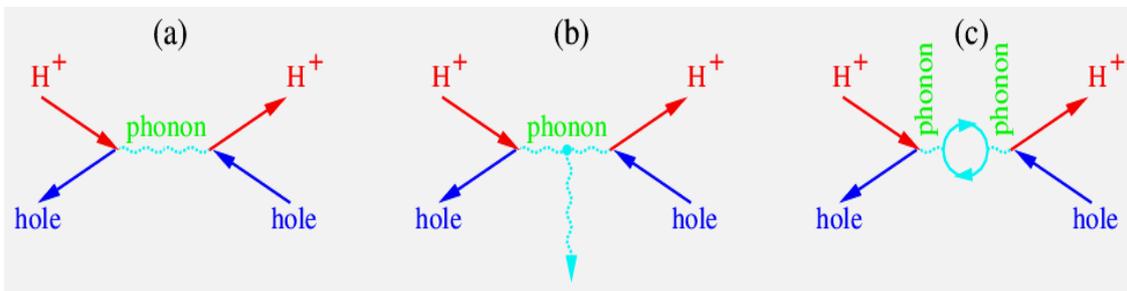
Here  $\rho$  and  $\vec{\mathfrak{S}} = \vec{v}\rho$  are the density distribution of gradient from all external and internal forces acting on a body as immersed in the superfluid quantum ether and the 3D current density, respectively. The vorticities of hydrogen ions at hopping along the EZ water hexagonal complexes, (**Fig.22**), give a contribution to the 3D current density  $\vec{\mathfrak{S}}$  and, consequently, they are sources of the particular field.

In their motion, there are several ways through which protons can transfer their information or energy. Let us consider some typical Feynman diagrams (i) of elastic scattering of a hydrogen ion on a hole (it is a vacant place for the hydrogen ion) and (ii) tunneling of a hydrogen ion through some obstacle. These processes are shown in **Figs. 24 and 25**, respectively.

Two processes shown on these figures, illustrate the elastic scattering of a hydrogen ion on a hole and tunneling of a hydrogen ion through an obstacle. The first figures (a) show ideal processes without loss of energy. While the second figures (b) show processes with loss of the energy that is dissipated into heating the water. Causes of this dissipation can be presence of "mind contaminants" that dissipate phonons generated in the course of these processes. It means that for avoiding the dissipations *we need to have a clear water, which is the case in the EZ-phase*.



**Figure 24.** Elastic scattering (a) of a hydrogen ion,  $H^+$ , on a hole; (b) scattering of a hydrogen ion with the energy dissipation because of radiation of a thermal phonon; (c) elastic scattering of a hydrogen ion on a hole accompanied by creation/annihilation of two virtual particles.



**Figure 25:** Tunneling: (a) of a hydrogen ion,  $H^+$ , occurs by its annihilation with a hole and radiation of the phonon. This, after a while, generates pair of a hydrogen ion and hole; (b) generation of pair is

*preceded by scattering of the phonon on a mud with loss of energy; (c) tunneling of a hydrogen ion is accompanied by creation/annihilation of virtual particle-antiparticle pair.*

It should be noted that the mobility of the hydrogen ion is highest among many other ions, such as  $K^+$  and  $Na^+$  (**Atkins et al., 2009**) that are important ions for neuronal communications. These ions have individual ion pumps, while special water wires are prepared each time when a problem regarding the transport of hydrogen ions, protons, arises. One can assume that the aqueous proton transport (**Brewer et al 2001**) is set each time along most optimal paths, like the Bohmian trajectories of particles in the physical quantum space.

From the above we may conclude that EZ water represents a water space where the Grotthuss mechanism has a minimal loss of the energy at the hydrogen ion hoppings. Observe that the Grotthuss mechanism, along with the relative lightness and small size of the proton, possesses an unusually high diffusion rate of the proton in an electric field, relative to that of other common cations (**Atkins et al, 2009**). Therefore, we will assume that along the water wires the water viscosity vanishes (theoretically, we will assume the viscosity inside the water wires in the average is zero). On the other hand, we assume that there is a potential energy due to which a surprising phenomenon is revealed. Namely, an excess proton charge defect creates its own aqueous transport pathway by shuttling water molecules through it into the hydrophobic nanoconfined space (**Peng et al, 2015**). Such superconductivity is also found by Sbitnev (**Sbitnev 2016**), where the average viscosity coefficient declines to zero. This also could in part explain ultra-rapid brain response.

### 7.3 The Path Integral: Gap Junction Channels

There are rigorous mathematical proofs concerning extraction of the Schrödinger equation out of the Feynman path integral (**Feynman, 1965; Derbes, 1966**), as well as solutions of the Schrodinger equation by applying the same path integral technique (**Sbitnev, 2013**). Following this statement, the Schrödinger wave equation can be resolved by heuristic writing of a solution by using the Huygens Principle, (**Sbitnev, 2012**), which mathematically appears as):

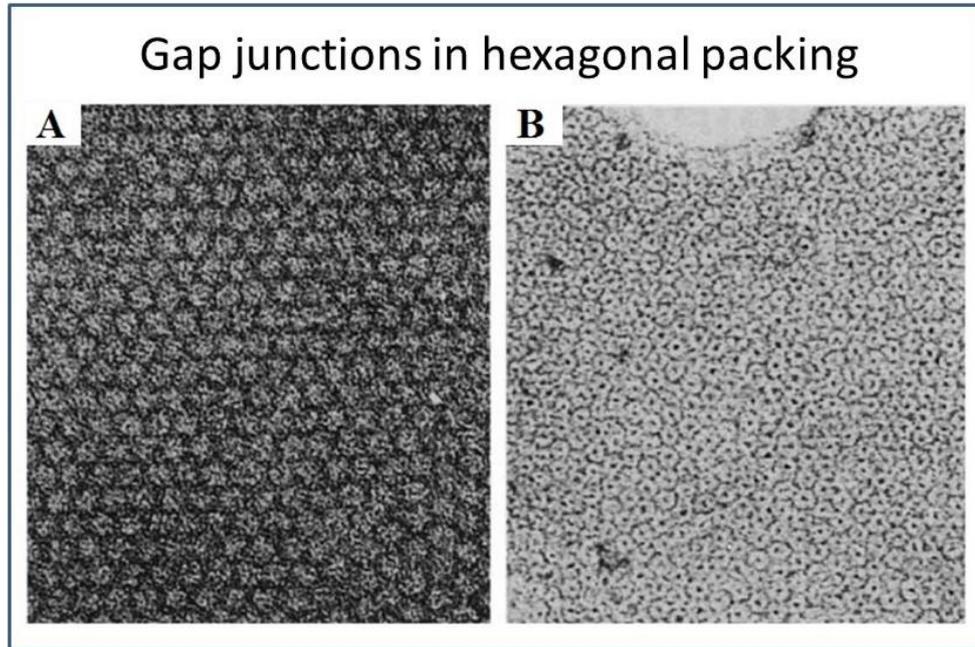
$$|\Psi(\vec{r}, t)\rangle = \int K(\vec{r}, \vec{\xi}, t) \Psi(\vec{\xi}, 0) d\vec{\xi}. \quad (7)$$

The propagator  $K(\vec{r}, \vec{\xi}, t)$  bears information about the neuron tissue that is contained in the terms covered by curly bracket in the Schrödinger equation (4). Here the integral summarizes all paths leading from a source of radiation to a point of observation (receiving information). Between the source and the end point of receiving information there can be placed many biological agents such as microtubules, gap junctions, etc. They are represented in the Schrödinger equation by the potential energy term  $U$  and, consequently, interfere with the wave function.

The microtubules, for example, can play a role not only of a component of the cellular skeleton and to provide transportation of biological molecules on long distances, but also may serve as a sort of memory, as it was suggested by Hameroff and Penrose (**Hameroff and Penrose, 2014a; Hameroff and Penrose, 2014 b; Hameroff and Penrose, 2014c**), see **Fig. 17**. As was shown recently by Tuszynski et al., the microtubules possess memristive properties (**Tuszynski, 2019**), what makes them suitable for a long-term storage of memory.

The gap junctions, in turn, are specialized intercellular connections between different cells directly connecting the cytoplasm of two cells; see the insert in **Fig. 27**. The gap junction, electrical synapses,

exist in every major area of the central nervous system (**Connors and Long, 2004; Söhl et al, 2005; Meijer and Dermietzel, 2006**). Gap junctional intracellular communications are formed into ordered arrays showing predominantly hexagonal packing, (**Fig.26**), with about 6 to 9 nm center-to-center spacing (**Zampighi, 1987; Berg et al, 2002**).



**Figure 26:** Gap junctions stained with (A) phosphotungstic acid,  $\times 580,000$ ; (B) and uranyl acetate,  $\times 470,000$ . Well visible is the hexagonal packing. Photos are borrowed from (**Zampighi, 1987**).

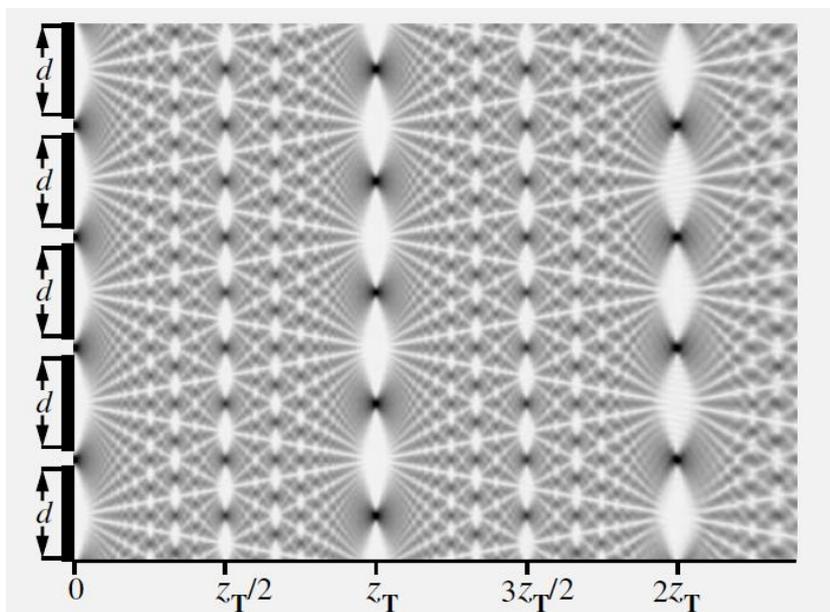
Such ordered arrays represent slit gratings for the ion beams passing through them and reproduce an interference effect behind them. In fact, it is an ideal interference device for ensuring the information processing. A wave function describing the interference pattern from a grating containing  $N$  slits and placed in the 2D space is

$$|\Psi(x, z)\rangle = \frac{1}{\sqrt{1+i\frac{z\lambda_{dB}}{2\pi\varpi^2}}} \cdot \sum_{n=0}^{N-1} \exp\left\{-\frac{\left(x - \left(n - \frac{N-1}{2}\right)d\right)^2}{2\varpi^2\left(1+i\frac{z\lambda_{dB}}{2\pi\varpi^2}\right)}\right\}. \quad (8)$$

Here  $\varpi$  is a width of the slit,  $d$  is the distance between slits, and  $n$  is the sequence number of the slit.  $\lambda_{dB}$ =the de Broglie wavelength of hydrogen ions,  $\lambda_{dB}=h/(c_s \cdot m^*) = 8.2E-34 \text{ J.s}/(1508 \text{ m/s} \cdot 1.83E-27 \text{ kg})=0.3 \text{ nm}$ . The slits are placed along the  $x$ -axis, with equidistant spacing between them, and the  $z$ -axis is perpendicular to the grating position. The density distribution of this wave function  $p(x, z) = \langle \Psi(x, z) | \Psi(x, z) \rangle$  is shown in **Fig. 27**.

The gap junctions are observed predominantly on the glial cells, which number is much larger than the number of neurons in the brain. They are often strong enough to mediate close synchronization of subthreshold and spiking activity among clusters of neurons (**Connors and Long, 2004; Volman et al, 2011**). The gap junctions are a ubiquitous, yet underappreciated, feature of neural circuits of the mammalian brain. They may contribute to the cognitive processes in both aspects, namely, perception and attention (**Nagy et al, 2004**). Particularly impressive work in this range is the article by Richard

Maxwell (**Maxwell, 2009**) devoted to connections of a subtle world through chakras with the body organs by means of intercellular gap junction connections.



**Figure 27:** The density distribution of the wave function (8). Here  $z_T = d^2/\lambda_{dB}$  is the Talbot length adopted unit of length in the interferometry.

The latter mechanism provides a physiological modality underlying subtle energy systems. Here we have come close to understanding the importance of gap junctions, in connecting a lower level of the brain with the higher level. In addition, we highlighted proton transport through intracerebral fluid and the Grotthuss mechanism, picturing the water interface between the brain and the superfluid quantum medium (the quantum ether).

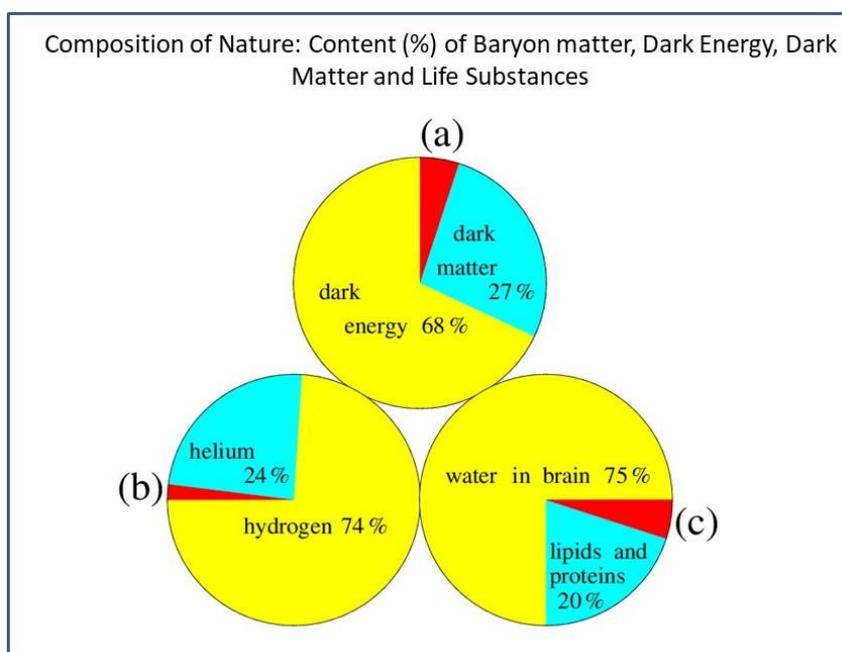
#### 7.4 The Universe Is Much Wider Than that Given by Baryonic Matter

On a wider scale, three charts demonstrate our place in the Universe, **Fig. 28**. Curiously, all baryonic matter composes only about 4% of total, much less than the collective dark matter and energy, according to current cosmology. One may say, that a boundless ocean of the dark substance occupies about 95% of total mass-energy content spans us, spreads among us, and stretches everywhere. It was mentioned earlier (**Sbitnev, 2019**) that the wave equations that describe cosmic microwave background fluctuations contain parts that reflect the fact that space is filled with dark energy and dark matter as expressed in related force density waves. It should be realized that our whole organism and thus our brain are permanently embedded in such force fields that likely may influence information flow, processing and storage in memory workspaces.

In turn, in the baryon sector, hydrogen is the most abundant chemical element in the Universe (74% and about 24% of all baryonic matter compose hydrogen and helium, respectively). Hydrogen, together with oxygen, forms a water that is considered as the mother of life on the Earth. Amazingly, the mammalian brain contains about 75% of water volume wise and over 90% molecular wise. (**Tarlaci, 2013**).

One may almost guess, therefore, that *human thought flows due to water and through water*. More mechanistically, we may say that water represents an interface between the human brain and the

Universe, (**Carniello, 2015**). Yet, it should be realized that humans even together with his extended mind occupies only a minuscule (invisible) percentage of the entire architecture of the Universe! Nevertheless, humankind can strive to finally understand its place in the Universe.



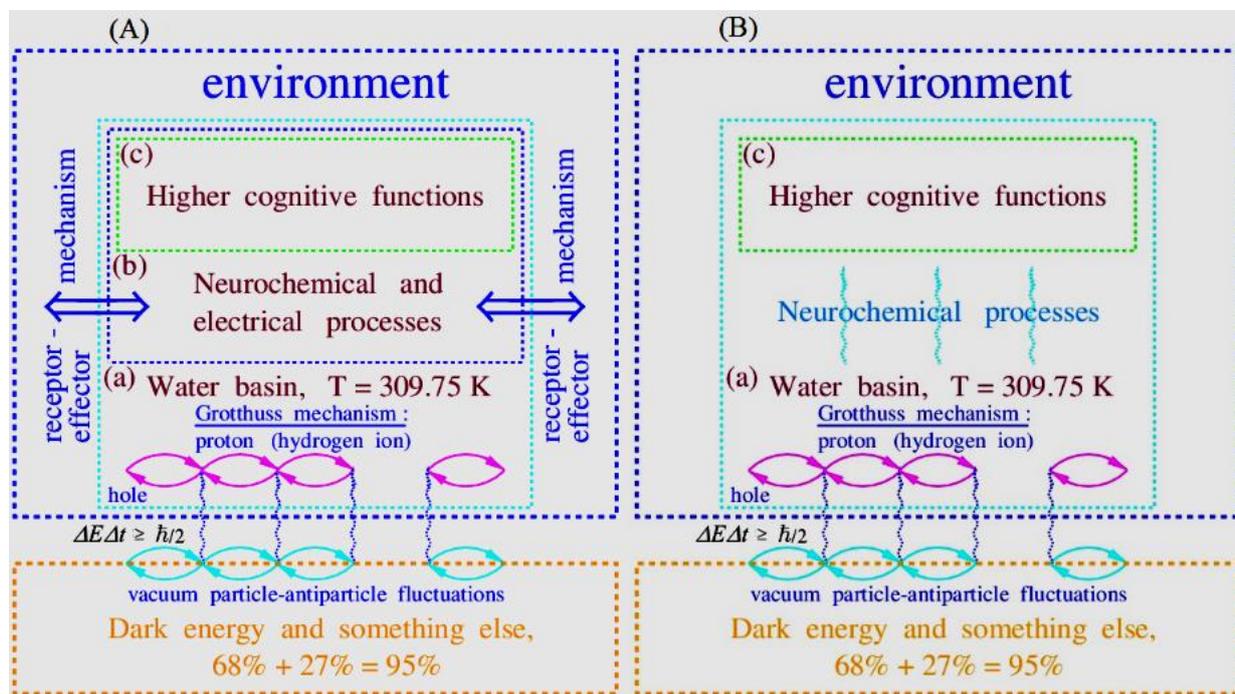
**Figure 28.** *Percent content of different substances in Nature: (a) only 5% of baryon matter represents our visible world. The other are dark matter and dark energy; (b) all heavy atoms represent only 2% of the visible baryon matter. The other are helium and hydrogen; (c) soluble organic matter, inorganic salts, carbohydrate make up only 5% of the brain substance. The other substances are lipids, proteins, and predominantly water.*

To show a place of the human consciousness in the Universe we give a conditional cartoon of the brain in **Fig. 29**. Two figures show the brain in two states – the awake brain, **Fig. 29(A)**, and the brain in REM dream, **Fig. 29(B)**. In both cases, the brain has a connection with the vacuum zero-point fluctuations due to protons of water. In the first case, however, because of a huge noise conditioned by the operation of receptor-effector mechanism of connecting us with environment, we do not sense tiny zero-point fluctuations. In the second case, the case of REM dream, the nervous tissues regulating the receptor-effector mechanism are in a deep rest and, therefore, there is no huge noise drowning out a faint stream from the depths of consciousness. In this state, we may experience dreams.

Perhaps, there are people that can have a perception of tiny fluctuations, coming from deeper layers of the consciousness, related to the dynamics of the Universe. These people, as a rule, are somehow in borderline states of their consciousness. For that reason, their psyche can be very sensitive to such tiny fluctuations (see **section 5.8**). These borderline states of the consciousness represent bifurcation conditions, according to a term from brain pathology such as in epilepsy (**Jin and Zong, 2011; Nemani and Binder, 2005**) and even in schizophrenia (**Wang, 2010; Mitterauer, 2014**).

Summarizing this section, here we tried to understand what mechanisms may be responsible for the exchange of information with the superconducting quantum ether. As was noted above, a main mechanism is represented by the Grotthuss process that can be effective when water is in the fourth phase. This process can be expected to exist near countless subcellular structures, including the cellular membrane of neurons in contact with the complex brain fluid constituents. In conclusion, note, that the

electromagnetic field can, in principle, be shielded by nearest neural tissues, whereas the superfluid field cannot. However, the latter is, in general, very weak and for that reason, one usually does not perceive it.



**Figure 29.** Conditional cartoon of a living being: (A) three-level diagram of brain organization in awake state: (a) a water basin containing all the other levels; (b) nervous tissue and glial cells, supporting electrical activity of the receptor-effector mechanism; and (c) higher cognitive functions creating consciousness as a paradox (Allakhverdov, 2000). All of this is backed by a dark substance – the "superfluid quantum space" (Sbitnev, 2017; Sbitnev, 2019); (B) three-level diagram of brain organization in REM dream state: here the nervous tissues regulating the receptor-effector mechanism are in a deep rest.

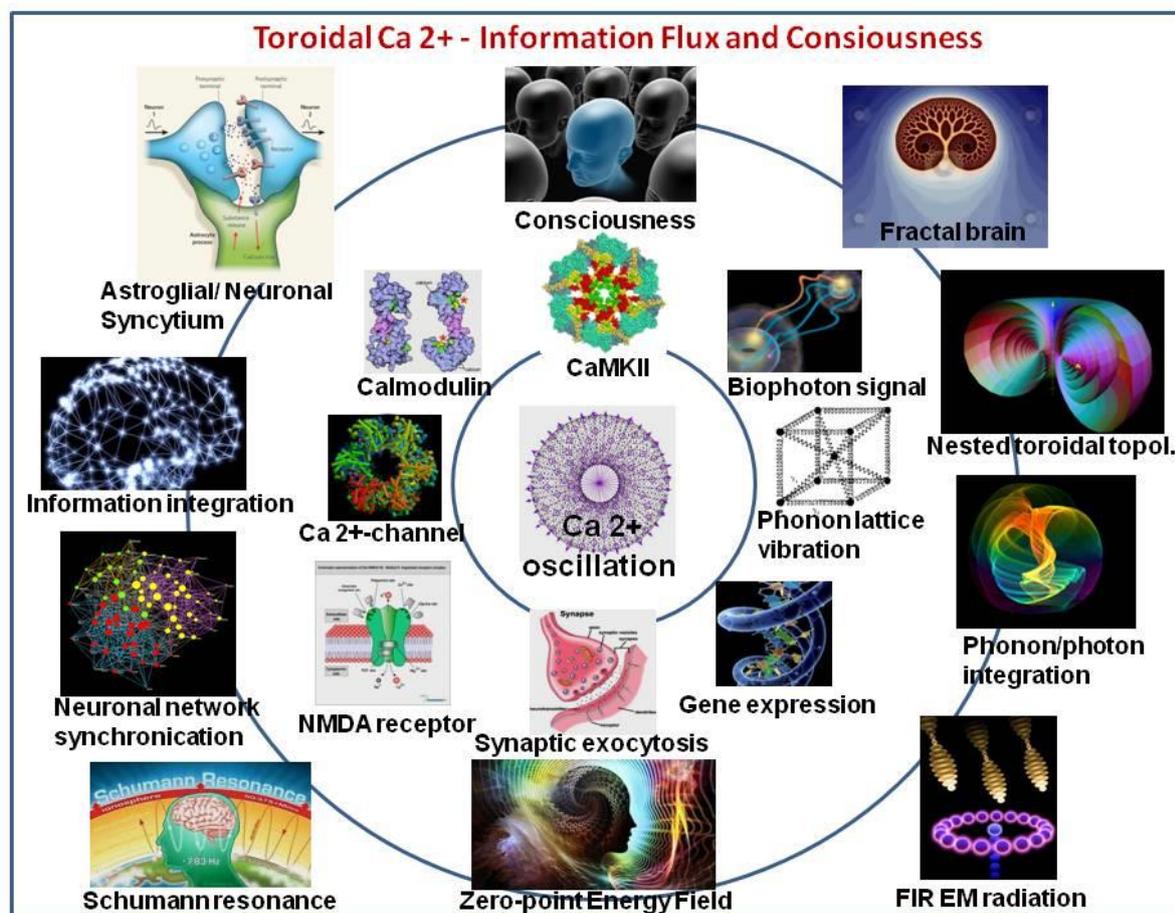
Yet, if coherency of the related wave information as well as that of water structures in the brain exists, it may become manifest. In fact, the above picture agrees with the de Broglie idea about existence of the pilot wave guiding the particle from the initial point  $\sim q_a$  to the final one  $\sim q_b$  (de Broglie, 1987), meaning that the particle and the pilot wave behave as one entity (see also Fig 9 A). The interference pattern in this case is defined for all subjects situated in the particular space from which the reflected waves are returned to the particle (Fig 9 A), as also demonstrated in the elegant hydrodynamic experiments (Bush, 2015).

## 7.5 The crucial informative role of $\text{Ca}^{2+}$ ions

Through the prism of the above description, we may now consider the consciousness evolving in the wet, warm, and noisy brain system. It interacts with a massive volume of memory stored in a deeper, finer-grained scale of a memristive system (Chua, 1971, 2011).

The interaction manifests itself through the destructive and constructive interference effects, like the effect of a vote. The memristive system by itself is based on the cellular organelles involved in the sequestration of calcium ions (networks of the granulated units of  $\text{Ca}^{2+}$ ), including the calcium-

calmodulin-dependent protein kinase II (CaMKII), which is implicated in the strengthening of active neural connections (Craddock et al, 2012).



**Figure 30.** The fractal organization of  $Ca^{2+}$  mediated cellular mechanisms related to conscious perception. The pivotal role of  $Ca^{2+}$  ions, as the second informational messengers in brain function is indicated at micro- and macro- levels. The inner circle is depicted anti-clockwise: Neuron/astrocyte mediated  $Ca^{2+}$  flux leads to activation of Calmodulin associated kinases (CMK11), calmodulin, NMDA-receptor/channel proteins and quantum resonance within Ca-channels that may stimulate synaptic neurotransmitter exocytosis. Outer circle macro -scale:  $Ca^{2+}$  flux in syncytia of neurons/astrocytes leads to phonon/photon mediated information storage and integration as well as neuronal assembly and neuronal network synchronization. The  $Ca^{2+}$  messenger function may be influenced by Schumann and cyclotron resonances by far infrared (FIR) radiation resonance as well as Zero-point energy (ZPE). The resulting phonon and photon scalar waves in the brain are integrated and protected against decoherence through toroidal processing. Topological integration on the brain macro scale is realized by torus nesting and self-similar fractal representation. This integral process may contribute to the creation of awareness and conscious perception in relation to the external world.

On the basis of the specific EMF frequency data (Geesink an Meijer, 2018a) and the known sensitivity of  $Ca^{2+}$  to EM radiation, we fully support the notion that  $Ca^{2+}$  takes a crucial position in the integration of the distributed information within the brain, not only due to its specific atom electronic properties (empty atomic electron shells) and thereby its potential for entanglement and superposition,

but also since it affects at least 10 different cellular processes that have been shown to correlate with modalities of conscious perception (reviewed by **Pereira, 2007; Pereira and Furlan, 2009**, see also **Fig. 30**). Interaction of general anesthetics with NMDA receptor/channel function have been shown to induce the loss of consciousness (**Flohr, 1998**), but has also be related to high affinity for tubulin poteins, thereby blocking their Tera-Hertz oscillations in microtubules (**Craddock et al., 2017**). Earlier it was shown that electromagnetic fields may influence cell function via activation of voltage-gated Ca-channels in the plasma membranes and that this can both lead to beneficial and adverse effects in the exposed cells (**Pall, 2013**).

In addition, phonon patterns affect trapped  $\text{Ca}^{2+}$  ions in astrocytes, a process that is instrumental in the formation of quantum information states that in the proposed astroglial/neuronal "protectorate" may survive decoherence (**Pereira, 2007**). Interestingly the magneto-sensitivity of  $\text{Ca}^{2+}$  is well known (**Adey, 1993; Liboff, 1985**) in the sense that calcium transport and protein/channel binding may be largely affected by magnetic fields with ELF radiofrequency signals. The influence of this signaling of the so-called Ca- ion cyclotron resonance is supposed to be due to the induction of exclusion zones in the structured state of cytoplasm water molecules forming coherent domains. Biological effects are influenced by oscillating magnetic fields, depending on their frequency. This special fractal scaled  $\text{Ca}^{2+}$  behavior supports the premise that astrocytes support functions additional to the normal neuronal mechanisms. In fact, they contribute directly to cognitive functions and resultant behavior (**Pereira and Furlan, 2009; Bull, 2014**). Of note, grafted human astrocytes in mouse brain have a higher rate of  $\text{Ca}^{2+}$  flux and are much larger and more complex than normal mouse cells and, interestingly, showed enhanced learning, memory and plasticity (**Han et al, 2013**).

An important aspect of this 'calcium ion' hypothesis of mind is that any instantiation of mind should be intimately connected with early stages of memory processes. This is a requirement that is essential to 'mind' since it should be capable of dealing with the new incoming information, by establishing new attractors in the "domain" of consciousness and also must be capable of integrating different aspects of incoming information over time. It has been shown that  $\text{Ca}^{2+}$  ions are also hydrated, and, in principle, their behavior can be described by similar hydrodynamics and path integral approaches, as described in the previous for hydronium ions. Thus, just as there is a wide variety of intercellular  $\text{Ca}^{2+}$  waves in different cell types, so is there a corresponding variety in their mechanism of extra-cellular propagation. Nevertheless, two basic mechanisms are predominant: propagation by the diffusion of an extracellular messenger, and propagation by the diffusion of an intracellular messenger through gap junctions. Sometimes both mechanisms operate in combination to drive an intercellular wave. Of note,  $\text{Ca}^{2+}$  waves can exhibit spiral patterns (**Tang and Wang, 2009**) and is also influenced by external cyclotron EMF resonances (**Meijer and Geesink, 2015**), both supporting our concept of toroidal flux mediation in the brain.

### **Conclusions in relation to section 7**

- Consciousness states are, at least partly, received from the superfluid quantum space/zero-point energy field and the information flux is likely bidirectional (back reaction). Consequently, a field-type of cosmic connectivity is attained, necessary for global synchronization in the brain and of the brain with the cosmos.
- The fractal water compartments in the brain function as a superconductive antenna for the ZPE/superfluid quantum space wave information (see **Geesink and Meijer, 2019a**). This aspect extends to interstitial spaces and non-neuronal cell types, in which spiral  $\text{Ca}^{2+}$  wave fluxes, that mediate multiple bio-information mechanisms in the brain, play a crucial role.
- For wave-information transfer in brain, one needs two separate mechanisms operating in brain water: the intermolecular jump of hydrated protons (Grotthuss mechanism) for superconductive states as well

as a different mechanism of wave/particle diffusion. The latter propagation process in the whole brain is facilitated by quasi-particle formation of solitons (rotating electrons or protons that become dressed with phonons/photons). Hydrated protons have been shown to be quasi particles with solitonic solutions.

- The latter implicitly introduces the aspect of vortex-like rotation and toroidal geometry of energy trajectories. Rotatory mediated toroidal flux is likely important for information integration and error correction of various forms of wave energies.

- Holographic memory storage and retrieval can be understood from a 4-D situated event horizon workspace that is associated with the brain but not reducible to it. The cerebrospinal and interstitial water compartments are equipped with, and sensitive to, external solitonic excitations. In conscious states in brain and the entire cosmos, they can function as the communication conduit between zero-point superfluid space and modalities of life organisms.

- Current observations on relative intelligence of hydrocephalic patients, life panorama aspects of NDE experiences, and pre-cognition PSI phenomena (see **sections 5.8 and 5.9**) can be better understood through the present superfluid and superconduction model.

## 8. Comparison of the Present Model with Other Current Models of Consciousness

*Definition of our hypothetical model:*

*Graded states of consciousness in the universe (dream states/primary awareness/(sub)-conscious states/transpersonal experience/universal consciousness) are scale invariant and are guided by a pattern of semi-harmonic quantum waves (meta-language of the GM-scale principle). The latter originates from a superfluid quantum space/zero-point energy field (SFQS/ZPEF), creating pilot wave induced resonance and cosmic connectivity. The steering of life processes is realized through semi-harmonic tuning of fractally structured water, in a dynamic relation with vibrating macromolecules, such as hydrated proteins and DNA, in several cell types of the human brain and in its aqueous compartments. Conscious states arise through solitonic communication with a field-receptive, workspace, that is associated but not reducible to the brain. It implies a holographic memory workspace (“event horizon”), that supervenes brain function and is organized according to toroidal geometry. Collective pilot waves, including their backreaction lead to a conformal cosmic information field, representing the mental attribute of reality also expressed in human individuals.*

In which aspects does our present model differ from earlier proposed concepts on consciousness and its supposed neural correlates?

### Global workspace models

These models are often inspired by “Global workspace theories” of **Baars et al (2013), Dehaene, et al (2003, 2017), Table 3**, left column). The various postulated concepts cannot be treated in detail here, (see **Seth, 2007**, for a short but an adequate review). Interestingly, many of these models are also based on an *internal self-model* in the framework of a supposed global workspace. In the latter models the unresolved problem of instantaneous binding of distant brain nuclei, in relation to our *integral* observation and sensing of our world, is approached by assuming multiple “broadcasting” hot spots in the neural networks of the brain, that according to the present authors may communicate via resonance of standing waves, phase coupling or even in a spiral (toroidal) mode. Some even consider the integrating activity of this broadcasting of information as the very process of realization of consciousness (**Baars et al 2013; Tononi, 2008, 2014, 2016; Dehaene, et al 2003**), in which *consciousness is just brain-wide sharing of information* that is in the global workspace.

However, some aspects remain to be established: what is the physical mechanism behind this supposed broadcasting phenomenon (multi-synaptic, electromagnetic, holographic, or (bio)photonic), in what form is the particular information sent and also how is the received information in the cortex integrated to conscious moments with meaning? In the present work, we propose that such a complex phenomenon requires an information-integrating, workspace, in which the broadcasted information can be put into the context of the entire memory content of the organism. **Dehaene (2017)** assumes two types of information processing: a selection of information for "global broadcasting", sharing it across modules and holding it over time, in order to make it available for computing and reporting. In addition, he assumes a self-monitoring of this information in relation to reflexive aspects and error correction as a *sort of meta-cognition*. Prefrontal cortex neuronal circuits, or even parallel circuits that are operating on the same sensory data are supposed to entertain error correction and differentiation between self-generated versus externally driven representations.

Yet we question, if such synaptic mechanisms are rapid enough or, *alternatively*, that phonon/photon/soliton mediated communication should also play a role. This should also account for potential extra-sensory information such as NDE, blindsight and inter-personal data sharing is integrated in this concept (see **section 6.8**) It has been argued by **Ismyl and Rizvi (2018)** and many others, that synaptic transmission and axonal transfer of nerve impulses are too slow to organize coordinated activity in large areas of the central nervous system. The duration of a synaptic transmission is at least 0.5 ms, thus the transmission across thousands of synapses takes about hundreds or even thousands of milliseconds. The transmission speed of action potentials varies between 0.5 m/s and 120 m/s along an axon. More than 50% of the nerve fibers in the corpus callosum are without myelin, thus their speed is reduced to 0.5 m/s. How can these low velocities (i.e. classical neurophysiological signals) explain the fast processing in the nervous system?

A more meta-cognitive form of consciousness rather will contain a graded modality of hierarchically as well as referential ordered and bodily determined working structure, that is essential for fully coordinated action, and was earlier called "individuated information utilized in action" (**Jonkisz, 2015**). Interestingly, such a conscious state space (**Bekovich-Ohana and Glicksohn, 2014, Brandenburg et al 2016**), was modeled by a geometry of two concentric spheres (not unlike our torus model), representing a phenomenological space with three dimensions: time, awareness and emotion.

As mentioned above, we tentatively add to this configuration a fourth space-time dimension in relation to self-consciousness in continuous contact with an extended consciousness or awareness continuum that is defined by us and many others as *universal consciousness*. The latter aspect rejects the usual framing of a mental workspace as a dualistic concept, since we envision our proposal of the extended brain as being *derived* from universal consciousness, as the very source of all that exists (see **Goswami, 1990; Kastrup, 2016; Meijer, 2019a**). In a similar manner, we previously treated life as originated and thereby *extended* from the quantum vacuum from its substance, behavior and laws.

**Multi-dimensional models.** Our model is, at least to some extent, related to earlier proposed quantum/spacetime models of **Pribram (2004)** and **Mitschell and Staretz (2011)**, on the holonomic brain, as well as to the electromagnetic field brain theories of **McFadden (2007)** and **Pockett (2012)**. It also bears some resemblance to the orchestrated objective quantum reduction model of **Hameroff and Penrose (2014)**, the TGD universe framework of **Pitkänen (2016)**, and relates to the so-called dissipative information brain model of **Vitiello (2001)**, (see **table 3**, right column), as previously reviewed by **Meijer and Raggett (2014)**.

Current Models of Human Consciousness	
Neuro-correlate models	Quantum/Spacetime models
Global Workspace model- <b>Baars/Dehaene</b>	Wholeness/Implicate order model - <b>Bohm</b>
Multiple Drafts theory- <b>Dennett</b>	Quantum field model- <b>Jibu/Yasue</b>
Dynamic Core/Neural Darwin. model- <b>Edelman</b>	Quantum brain dynamics - <b>Umezawa</b>
Information Integration theory- <b>Tononi/Koch</b>	Dissipative brain model- <b>Vitiello</b>
Thalamic Cortical Rhythms model- <b>Llinas</b>	Holonomic mind model- <b>Pribram</b>
Coalitions of Neurons model- <b>Crick/Koch</b>	Attention quantum zero effect model- <b>Stapp</b>
Field models- <b>Kinsbourn/McFadden/Pockett</b>	Psychon brain dynamic model- <b>Beck/Eccles</b>
Subcortical models- <b>Penfield/Merker/Ward</b>	Ion-channel coherence model- <b>Bernroider</b>
Internal and World Simulation model- <b>Revonsuo</b>	Orch. Obj. Quant. Reduct.- <b>Hameroff/Penrose</b>
Retinoid model- <b>Trehub/Metzinger</b>	Spin- mediated Consc. Model - <b>Hu/ Wu</b>
Self-model theory- <b>Metzinger/Hesslow/Grush</b>	EM- field models- <b>McFadden/Pockett</b>
Sensimotor Theory model- <b>O'Regan/Noë</b>	Holographic Resonance model- <b>Mitchell</b>
Supramodular Interaction theory- <b>Morsella</b>	Hierarchic model consciousness.- <b>Kaivarainen</b>
Multilevel Feedback model- <b>Haikonen</b>	Dual-time Supercausality model - <b>King</b>
Intermediate Level theory- <b>Jackendorf</b>	Topological Geometro Dyn. Mode I- <b>Pitkänen</b>
Radical Plasticity thesis- <b>Cleeremans</b>	Poised State Quantum model- <b>Kauffman</b>
Collorary Discharge Attention model- <b>Taylor</b>	Photon Med. Consc- <b>Bókkon/Dotta/Persinger</b>
Attention to Memories theory- <b>Izhikevich</b>	Noetic Field theory - <b>Amoroso/DiBiase</b>
Bicameral Mind model- <b>Jaynes</b>	Zero Point Energy model- <b>Keppler/Cagliuiri</b>
Operational Architectonics model- <b>Fingelkurts</b>	Neural Field theory- <b>Robinson</b>
Self Comes to Mind model- <b>Damasio</b>	Infinite Spiral Staircase model- <b>Hardy</b>
Free-energy Unified Brain theory- <b>Friston</b>	Nuclear Spin Neural Qbit model- <b>Fisher</b>
Triple aspect monism model- <b>Pereira</b>	Oscillating Agent Quantum model- <b>Pliukynas</b>

**Table 3:** Current neurological and neural-correlate models (left) and quantum/spacetime models (right). References to the neuro-correlate models can be found in **Seth (2007)** and for the Quantum brain models, see **Meijer and Raggett (2014)** and references in the present paper.

Implicitly, a major difference with the abovementioned models is that it is not solely related to the known neuronal/astroglial based central neural-system, but that *an additional* modality of an associated mental workspace in a 4-D context is introduced (see also **Beichler, 2012 a, b, c; Carter, 2014**). This workspace mirrors our total of experiences and is sensitive to relevant information derived from various force fields of nature such as geo-magnetism, gravity, Higgs field, as well as zero point and dark energy. We presume, as stated before, that it also comprises an even larger connecting principle in the sense of *universal consciousness*, as it is inferred by some of us (**Meijer, 2018a**). In this sense, our model supports that of **Haramain (2007 and 2016)**, (dual toroidal/wormhole geometry in physics and cosmology), as well as the model of **Hameroff and Penrose (2014)**. The latter addressed quantum gravity mediated communication with information on the Planck scale. The holonomic models mentioned in **Table 3**, of **Pribram (2004)**, **Mitchell and Staretz (2011)**, and **Amoroso and DiBiase (1999)**, largely stimulated our present concept. Reports on the crucial role of consciousness in proper functioning of the brain was emphasized by **Darmos, 2019**, and on the unitary relation of brain and cosmos from an energetic point of view by **Persinger and St-Pierre, 2015**, both supported our ideas on the extended brain in relation to the whole universe.

Of particular interest are the studies of **Atasoy, 2015, 2016, 2017**, that revealed a distinct presence of harmonic brain waves as related to the connectome. The researchers used data from two imaging techniques – magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI) – to create three-dimensional maps of the structure of the brains of a group of individuals. The MRI- data yielded the

structure of the cortex and the DTI yielded an anatomical map of the underlying connections of the white matter in the brain. The team then analyzed these brain maps using the mathematical framework of Laplace Eigenmodes, or harmonic waves, which describe natural vibrations of a system where all parts move together at the same frequency. See for this aspect also the adequate paper of **Joye, 2016**. Thereby, they could ask the question: how these harmonic patterns, or connectome harmonics, actually *make up* the fMRI data. The collective data indicate that a new language emerged to describe both the spatial and temporal elements of neural activity. Namely, the patterns tell which regions should be synchronized with each other at a particular frequency, and allow to characterize the fMRI data as a combination of these patterns.

These authors, interestingly, suggest a *musical analogy*, since the patterns can be compared to musical notes composing a complex musical piece, very much in line with the present paper (**Section 6.10**) that functional networks of the human brain are probably predicted by semi-harmonic patterns, ubiquitous throughout nature. Therefore, the model of Atasoy about human brain networks, may have a direct relation with the proposed GM-scale: both models make use of eigenfrequencies, coherent behavior, connected harmonic patterns, overlap between different state networks, harmonics corresponding to different frequencies (wavenumbers) and based up on a general physical principle of self-organization.

**Atasoy et al., 2015**, in this respect refer to the classical Chladny vibration patterns that were recalculated earlier by us (**Geesink and Meijer, 2016**), showing a perfect fit with the frequencies of the GM-scale. The introduced framework of harmonic brain modes, therefore, not only establishes a relation between the spatial structure of correlation patterns and temporal oscillations (linking space and time in brain dynamics), but also enables a new dimension of tools for understanding fundamental principles underlying brain dynamics in different states of consciousness. **Atasoy et al., (2018, see Fig.31)**, more recently examined the minds of 12 people treated with placebo or on LSD, and listening to music. They recorded their brain activity through the lens of the brain's underlying connectome-harmonics.

What they found was that under the influence of LSD, more of these harmonics were contributing to brain activity and their strength of activation was also increased. The brain was essentially activating more of its harmonics simultaneously, and in new combinations. Apart from combinations of harmonic EMF *frequencies* also the aspect of *wave amplitudes* should be taken into consideration. **Kraikivski, 2019**, postulated the importance of the amplitude of coupled oscillators for the creation of consciouspercepts. Interestingly, the author postulates the functionality of an *operational map isomorphic to a distance matrix with space-like properties* that would serve as a timeless linking (integrating) unit that allows a rapid selection of a repertoire of functional states, encoded in amplitude patterns of oscillatory processes.

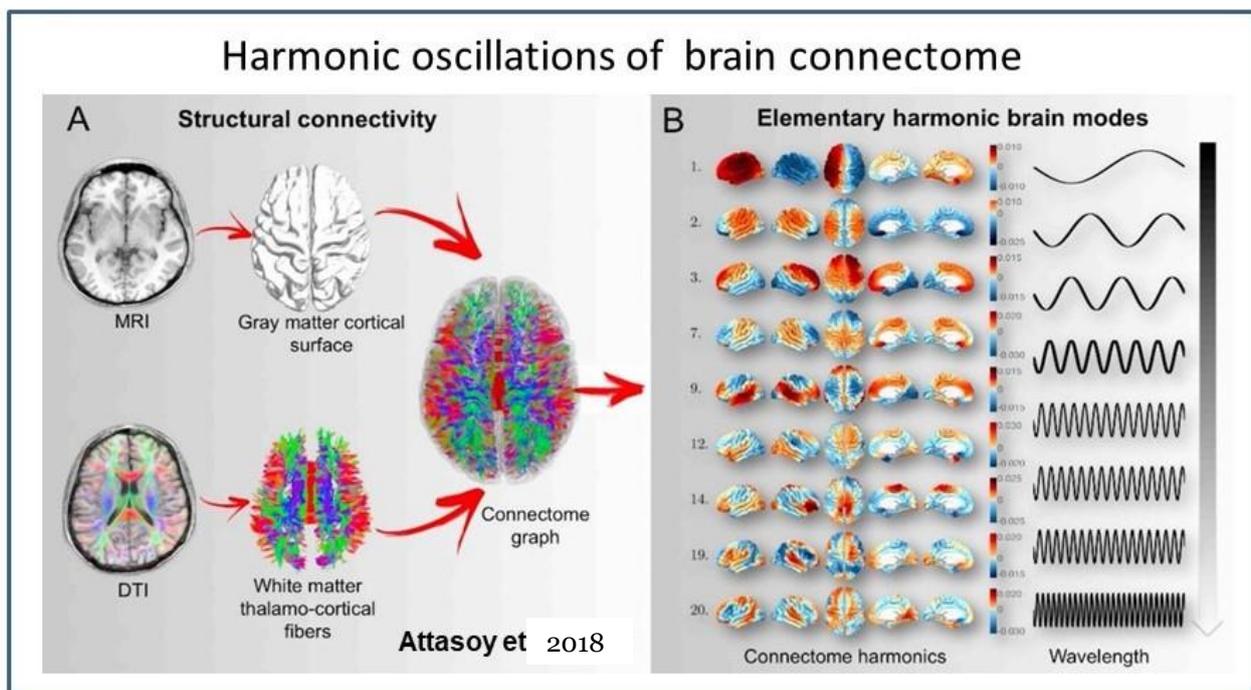
This, very much, resembles the concept of a guiding/supervening holographic memory workspace as envisioned in the present study. The latter is also true for the Fractal-like Information Integration Theory of **Bandyopadhyay et al.**, as discussed in section **5.10**, although we preferred the use of nested toroidal geometry for describing self-referential information flow and also added the aspect of an extra 4-D spatial dimension to arrive at a cosmic mental workspace concept by which we integrated mind/matter aspects in the consciousness framework.

**Table 4: Literature compatible with and/or supporting the present brain model concept**

<b>Scientific subject</b>	<b>Author(s)</b>	<b>Congruent aspect</b>
Global Workspace model	Baars/Dehaene	Long dist. broadcasting commun. brain
Information-integration theory	Tononi/ Koch	Information core concept
Orchestrated Objective. Red. Theory	Hameroff/Penrose	Q- coherent oscillatory tubular proteins
Projective Mind Hypothesis	Williford et al,	Virtual projective integrate brain
Toroidal Brain hypothesis	Tozzi and Peters ,	4D- Toroidal brain inform. domain
Human connectome and harmonic brain modes	Atasoy et al,	Harmonic frequency modes in brain
Glutamate-induced Biophotonics in neural circuits	Tang et al.	Physics of biophotonic brain comm.
Biophotonics redshift activity in brain	Wang et al,	Biophotons higher brain functions
Fractal Information geometric musical theory	Bandyopadhyay et al.	Fractal musical brain language
Operational Architectonics theory	Fingelkurts et al.	Operation of a mental brain domain
The Consciousness and Cosmos framework	Pereira et al.	Universal field of consciousness
Intuition as a holographic phenomenon of	Bradley	Intuition from holographic memory
Spin-mediated consciousness	Hu and Wu	Spin as mind-pixel in consciousness
Water as Conduit in Cosmic entanglement	Carniello et al.	Universal role of H <sub>2</sub> O in cosmol. order
Qualia: interaction with proto-consciousn.	Tressoldi et al.	Proto-consciousness domain
The Pribram-Bohm Holoflux Theory of Consciousn.	Joye S R	Holofield theory and implicate Order
Brain and neg-entropic entanglement	Poznanski	Consc. guiding encoded in ZPE field
Genomic consciousness in neurons	Cacha/Poznanski	Solitonic interactions with DNA
Physical bases to Consciousness	Persinger/ St- Pierre	Unified, non-local cosmic brain energy
Quantum Gravity and role of Consciousness	Darmos	Role of consciousness in physics
Two-brain hypothesis	Goodman et al.	Electro-ionic/ Electromagnetic brain
Nonsynaptic model of longterm memory	Cacha et al.	Engrams as phys. waves in interfacial water
Quantum physics of synaptic transmission	Georgiev et al.	Q. tunneling in neurotransm. Release
Systems of oscillators for conscious percepts	Kraikivski	Distant space-time matrix as operat. map
Holoinformational model of consciousness	Di Base	Superimplicate order in organizing Mind
Nature of Mind and Consciousness	Greyson	Is consciousness only produced by the Brain
Integral Relativity of Awareness	Neal	Role of photon/phonon symphonic resonan.
DNA resonance code as neural code	Savelyev e al.	Proton oscillations in DNA morphgen. field

It is striking indeed that many related and recent studies on consciousness contain the suggestion that a supervening memory workspace is required to understand an integral operation of the brain on the brink of chaos, as a sort of quality controlling and updating system. Such ideas take quite different forms but, at least partly, support our present concept (see **Table 4**). This is certainly true for the very elegant consciousness model of **Fingelkurz et al (2010, 2014)**, called nested operational architectonics of the brain. In this model it was postulated that an electromagnetic brain field (see also **Kida et al, 2016**, for a fractal representation) connects a mind-subjective space-time to a distant physical space-time. Meta-cognitive aspects of consciousness on the basis of current physics and cosmology were also proposed by **Pereira et al., (2018)**, postulating a matrix of reality being an N-dimensional combinatorial state space of eternal self-organizing elementary energy forms. This is seen as the ground of reality as a universal field, potentially encompassing all possible manifestations, either material or mental, connected via a transitional zone to a manifest world with its informational and qualia endowed aspects.

**Poznanski et al., (2018, 2019)** present a related theory in which brain consciousness is guided by hidden dynamics of dipole associated electrons, modeled by ZPE field/de Broglie/Bohm type of active information of oscillating waves as touched upon in our studies. The same group emphasized the importance of biophotonic/electromagnetic information transfer (**Cacha et al, 2014, 2017**) and in relation to this suggested the concept of a “Two-brain hypothesis”: one brain with an electro-ionic character and a simultaneously acting electromagnetic brain (**Goodman et al, 2015**).



**Figure 31.** (A) Structural connectivity of the human brain defined as the combination of local cortical, gray matter connections. (B) Elementary harmonic brain modes defined as fully synchronous patterns of neural activity are estimated as the harmonic modes of structural connectivity; i.e. connectome harmonics (after **Attasoy et al, 2018**).

These aspects of the theory are in striking agreement with the present model. Both the aspects of macro-quantum equation and error correction, on the basis of negentropic entanglement are mentioned, but lack the toroidal geometrics and the essential photon/ phonon/soliton coupling of

electrons as an optical guiding mechanism. We hold that a total acoustic semi-harmonic scaling of frequency patterns should be included, describing a balance of *coherent* but also *decoherent* modes, in order to construct the long-range order of phase synchrony in the consciousness code.

Further congruence with our model is noted from the studies of **Tressoldi et al. (2016)**, who conceive consciousness as an emergence of qualia through an interaction with a *supposed non-local proto-consciousness or proto-mind*, acting as an interpreter and decision maker, constantly redescribing its own activity enriched with the emotional value. A projective consciousness model was hypothesized by **Williford et al. (2018)** that combines a projective geometrical model of a perspectival phenomenological structure of the field of consciousness with a free energy minimization model of interference. This acts as a *4-D projective transformation*, that is instrumental in integration of perception, emotion and memory as well as in reasoning and imagination, in order to control behavior as well as to optimize resilience and preference satisfaction. The particular projective space proposed is virtual and outside our 3-D space as an extra parametric dimension active in creating a world model for the sake of selfhood, as a viewer or transcendental ego (our double or daemon unveiled) that provides a global availability and multi-modal information integration. This resembles the cosmological approach of **Pletcher (2019)**, that pictures consciousness as an interactive process of polarizing an observed source of a *higher dimensional (4+1) space* on to a cognitively modeled collapsed (3+1) space. All this supports our concept of the requirement of a reflexive 4-D workspace in a superfluid quantum space with rotatory geometry. Of note, Libet rightfully stated that the ultimate scientific challenge lies to produce experimental evidence for the two-way interaction between the conscious mind field (also called the stored mental map in a cognitive space) and the physical brain, as attempted in the present study.

Aspects of quantum holographic theory were also applied by **Bradley (2006)** and **Di Base, 2013**, in relation to intuitive perception of the future, based on interaction with non-local information through unfolding and harmonic resonance. This phenomenon, according to the authors, is not restricted solely to the brain but works also via information input in the cardiac system in the form of quanta of energy. These may arise from zero-point energy guiding that can overlap with the future (most probable potentials in the implicate order domain) and can lead to intuition, synchronicity, clairvoyance and telepathy (see also **section 5.8**).

The importance of a new scientific framework for the (re)-union of science and spirituality, was treated by the physicist **Faggin (2014)**, (the designer of Intel's first microprocessor), arguing that death is not final but rather necessary to dissolve the identification of consciousness with the body, freeing it to recognize its own true nature. The latter aspect was also treated in a very recent paper of the first author (**Meijer, 2019 b**).

## **Conclusion:**

(Self)-Consciousness is generally considered to arise from the brain thalamo-cortical recurrent neuronal activity. Yet, we hold that consciousness is at least partly *received* from a qualia space (superfluid quantum space/ZPE information field), to a sub-Planckian space-less and time-less dimension, bearing geometric patterns with mathematical relations (see **Penrose and Hameroff, 2011**). Communication from these fields takes place with photons/phonons/solitons through a holoflux of active information (as described by **Bohm and Peat, 2008**). This guiding process, in brain is , among other factors, mediated through its water compartments (cerebrospinal, interstitial, and intracellular spaces) in the form of freely moving protons, creating a superconducting medium. Hydrated protons are converted to and serve as antennas for electrons covered with phonons (phonon

dressed electrons or solitons) that exercise shaping effects on proteins and organelles. This can occur with the help of structured water, in which the information from the aforementioned fields is mirrored in fractal frequency wave patterns. This life information is not only stored by interaction with proteins and DNA but also, holographically, in a memory sphere (event horizon) around each cell that can be physically imagined in the vicinity of the plasma membrane with its complex array of intrinsic proteins and aqueous layers (**Meijer and Geesink, 2018a**). All this takes place in a fractal-like manner in the cell at the micro level (down to the level of elementary particles) as well as at the macro level. This implies entangled conditions in the whole brain and in the entire organism with its various organs and connective systems.

This concept is in line with the holofractal and semi-harmonic vibrations proposed by us that, as earlier mentioned, have been demonstrated in the brain by **Atasoy et al., (2015, 2016, 2018)**, with scanning techniques, and also showed by **Tozzi et al., (2016, 2017)** as a holographic domain that operates from a 4<sup>th</sup> spatial dimension, projecting into our 3D world. Both the *semi-harmonic* character of the EMF frequency pattern and the here proposed superfluid state, indicate vortex dynamics and toroidal geometry. Ca<sup>2+</sup> ions and their transmembrane gradients, as quantum information carriers, are envisioned by us as playing a crucial role in the cells and the integration of neuronal activity in various parts of the brain. Their quantum state is protected against the environment (decoherence) by being partially being enclosed in water gels or confinement within shielded Ca-channel proteins. Ca<sup>2+</sup> ions influence a spectrum of biochemical and biophysical processes in the brain (**Fig. 32**) and, partly, by astro-glial fluxes promote cerebral binding and synchronicity of brain activity, (**Pererera and Furan, 2012**). These, have been related to EEG signals with typical alpha-, beta-, gamma- and delta- frequency ranges. Therefore, water is seen as very central as a superconducting and phonon-antenna containing matrix that drives the balance of coherence/ decoherence of wave information to the left.

The present consciousness theory was confirmed by brain scanning in the abovementioned studies and is supported by the fact that certain hydrocephalic patients and other conditions with greatly reduced neuronal brain tissue may have an unexpected level of consciousness and intelligence (see also **Greyson, 2015, section 6.8**). We therefore present the concept of a *non-material, field-receptive, resonant, mental workspace* that is part of a *universal* mechanism of rotational information flow.

**Testability:** The present GM- EMF frequency scale concept is experimentally based, since it evolved from meta-analyses of more than 1000, mostly peer-reviewed, articles, consistently showing the particular frequency-band pattern in a variety of disciplines such as biomedical/biophysical studies, quantum entanglement studies, energy distribution of elementary particles, superconductor studies, clay material EMF properties and water absorption frequencies (**see table 1**).

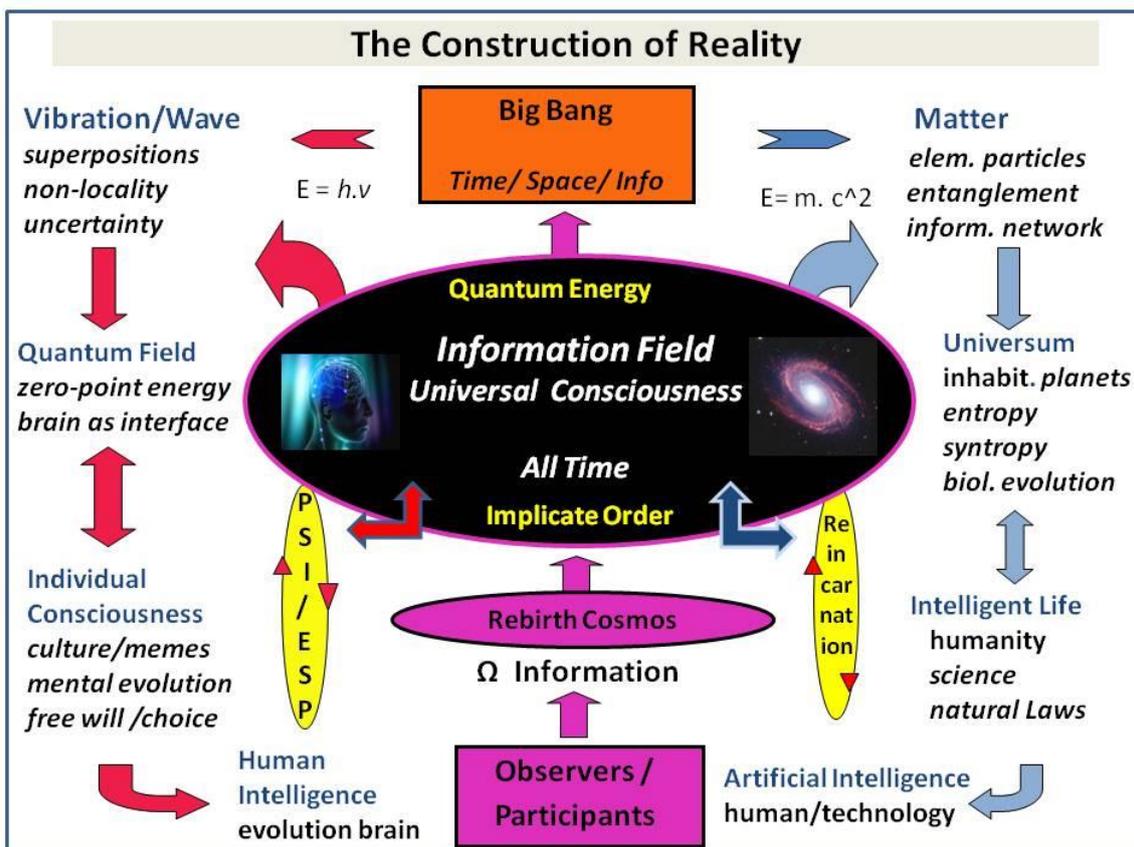
Our consciousness hypothesis can further be experimentally tested by exposing various types of brain tissues *in vitro* or *in vivo* to externally applied combinations of discrete EMF frequencies and/or selective shielding of such external EMF radiation modalities. This, through the use of advanced radiation technologies and/or specific EMF frequency modulating materials and probing of responses of electric activity or performing scanning of tissue slices or whole brain with various high-tech methods. The more transcendental aspects could be tested in further detailed analyses of a spectrum of known subjective experiences under the influence of discrete musical frequency bands and their combinations.

## 9. The Construction of Reality: An Integral Model

In this final section, the authors attempt to capture the various informational aspects, mentioned above, as well as their perception of reality, in a comprehensive scheme. This scheme is based on the central concept of universal consciousness in the form of a quantum wave knowledge field that is penetrating the whole of reality, as earlier proposed by various quantum physicists (see **Bohm, 1987; King, 2008; Primas, 2003, 2009**) and system biologists (see **László, 2005 and 2007**) as recently reviewed by one of us (**Meijer, 2019a**).

The Construction of Reality, depicted in the diagram of **Fig. 32**, is presented as the unfolding of basic information, which, initially, was present in a quantum-information field (black), which consisted of quantum energy, exhibiting an implicate and symmetric order. This field can also be seen as Universal consciousness, containing highly compressed information about all the available data from the present and the future (4-dimensional information from all time). In the integral scheme in **Fig. 32**, the unfolding of this information is expressed in a "dual" process consisting of:

- the processing of wave information in a transcendental superfluid quantum space (left column);
- the unfolding of information in the 3-D organization of a material world (right column).



**Figure 32.** An integrated scheme depicting the Construction of Reality, with its material (right part of the figure) and mental (left), aspects. This concept assumes a central quantum information field, that provides the very basis for creation of our universe and dynamically evolves further through cyclic feed-back processes from the present reality, in which natural (among others human) and artificial intelligence play crucial roles in observation and participation (see text for further explanation).

These separated processes do not imply the introduction of a kind of "Cartesian dualism", because they are strictly correlated, assuming that any form of matter also contains mental information, as exemplified in the wave/particle principle, as a basis for the description of nature. More classically, this duality of substance was conceived as panpsychism (see **Edwards, 1967; Griffin, 1997; Skrbina, 2005; de Quincey, 2010; Strawson, 2009**). Yet, in our view, Universal consciousness rather implies a dynamic field of information, with a continuous and bidirectional flow of generated information that originates from the entire universe, including our own world (**Meijer, 2012, 2019a**)

Extra-sensory communication (ESP) in telepathy and premonition as well as PSI-type of experiences, (clairvoyance, and near-death experience (NDE) phenomena, (see yellow ellipse on the left in the figure above), as have been treated before, can be seen as an interfacing of our brain with the universal information field. The latter cyclic process implies that death, that is often seen as a passage into another domain, is rather a continuation of an existing state, since individual (mental) information is, at any moment, already expressed in this universal knowledge field (**Wolf, 1996, Meijer, 2019b**).

By means of gathering and compression of all of the past and present information, the potential for the start of a new universe is produced. The final stage of this process was previously indicated as the Omega Point ( $\Omega$  Information, (in **Fig. 32**), as put forward by **Teilhard de Chardin**, (see ref. **King, 1996**), and more recently described by **Barrow and Tipler (1986) and Tipler (1995)**. This process of storing universal information also includes the processing, and internet-like distribution, of knowledge, as well as the compression of this information in the form of future (re)-formulation of the laws of nature. It also implies an ongoing communication and circular causality between the individual and its exo-world), and the latter should therefore include the universal information field as proposed here. The underlying implicate order, as an essential part of the universal consciousness, is viewed upon as containing the primordial recipe for the development of life and is the basis for the unfolding of the initially compressed information (see **Fig. 32**, information field in the center).

The entangled flow of mental and material information, pictured in the scheme, obtains a circular character through a final integration of the two knowledge domains at the Omega Point, ultimately resulting in a final state of our present universe and (tentatively) the birth of a subsequent version of it. The resulting (highly compressed information) is seen as a vision of an ultimate "theory of everything" which is then used as initial information for the next cycle. An ultimate "theory of everything" is defined here as a final statement of self-contained, internally self-consistent and compressed information that can be used as the input for a more refined version of the previous one (see bottom center of **Fig. 32**). Taking these different aspects into account, the *Universe can thus be seen as an intelligent living organism*, since it is self-observing, stores information, is therefore self-learning in a process of regeneration and reproduction. Human evolution is, in this view, an intrinsic part of cosmology in which intelligence plays a role in the birth and rebirth of the universe (called the rebound universe). This is often pictured as a circular process in which in each new "cycle" identical information is extracted and transferred. However, a model could, instead of a circular process, rather be better described by a mathematical well defined, (*double*)-*spiral or toroidal process* in which in each cycle novel information is gained and added to the already accomplished one.

Finally, at least one important question remains: if our Universe restarts itself through recurrent symmetry breaking, seemingly producing a division of mind and matter, what would be the potential role of information in this astounding process? It stands to reason that only the perspective for the evolution of intelligence afforded the *potential for the Universe to observe itself* in greater detail in a

self-learning mode, (**Meijer, 2012**). Only bio-friendly information, coupled to a universal memory, provided a recipe for creation of life and finally for intelligent and participating observers. Due to its entangled state with the material world, the universal source and knowledge field assumed by us, fulfills the necessary condition to function permanently as a bridge between the mental and material domains. In this manner it can also be instrumental in the ultimate reconciliation of this catastrophic separation of mind and matter. Of note, it was the gnostic prophet Mani (216-276 AD), who projected that reconciliation of mind and matter is the very aim of the Universe and will be brought about through the saturation of matter with light.... In the current scientific endeavor, information should therefore be positioned as the most fundamental aspect of the architecture of reality.

From the abovementioned phenomena it is obvious that a “final theory” in physics in the future, should describe *both* the *material* and *mental* aspects of reality and consequently must integrate a testable model of consciousness and self-consciousness. Such a comprehensive model of the whole should also be based on a solid mathematical and geometric framework and be compatible with *a completed theory of quantum mechanics*. It should thus include an integral description of the cosmos at the micro- and macro scale. The hypothesis that gravitational integration and compression leads to a universal memory space of which individual human self-consciousness is a discrete part, should be further investigated (see for more information on this aspect (**Carr, 2017, Hamein et al, 2016**)).

The present hypothesis on brain function, may for some readers imply that a part of our memory is *localized externally from our organism* (non-neuronal and even non-material). However, it should be realized that the present authors situate this mental workspace in an extra (fourth) spatial dimension, which is not visible to humans, so that differentiation between extra- and intra- neuronal is trivial, while the supposed mental modality is in fact quantum physically defined. In addition, in the present work we emphasize that aqueous compartments inside and surrounding the brain neuronal tissues may play a much more central role in the creation of (self)-consciousness than traditionally thought. We hold that these cerebrospinal and interstitial water compartments can function as an important part of dedicated antenna domains for receiving external and internally produced EMF signals. We stipulate that the information dissipating brain, as earlier described (**Vitiello, 2001**) may create our integral and universal memory, coined by the latter author as “*our double unveiled*”. Consequently, as mentioned above, we consider our concept to be compatible not only with present neurological concepts but also with trans-personal observations such as the unexpected brain to brain connections as recently experimentally demonstrated by **Hasson et al, (2013); Wackerman et al, (2003); Radin, (2004); Richards et al, (2005); Standish et al, (2004)**; as well as **Pizzi et al, (2004)**. In a similar vein, we should take into account the many cases of personal life panorama’s reported in stunning detail by the many registered near- death cases (for a critical discussion on the latter item (see **Lichfield, 2015**), in which astounding transpersonal information states of consciousness states are experienced in the absence of neuronal processing and fluxes of information in brain cortex (**Meijer, 2019b**)).

In the light of the superb treatment by Iain **McGilchrist, 2009** of the very different features of and crosstalk between right and left-brain hemispheres as well as its socio-psychological implications, one should ask how this very crosstalk is organized, and what determines its outcome, memory storage and retrieval. A personal supervening and integrating memory workspace, that, among others, is mirrored in the water compartments inside and surrounding the brain, as postulated in the present paper, could be envisioned as a “third hemisphere” in a 4D context, that earlier was framed as our “Double” and long ago by Greek philosophers as our “Daemon”.

It is shown in the present paper that the consciousness aspect of bottom up panpsychism can be reconciled with the “top-down aspect” of a retro-causally driven guiding field of thoughts and qualia, (see a stimulating discussion on that in **Kastrup (2017, 2018)**). We submit that this occurs due to their physical relation, being a two-way recurrent information flux that can be modeled by the self-referential toroidal geometry, in which consciousness returns to itself in an everlasting dynamic mode. Nature thus seems to unfold itself through the operation of natural laws within a matrix of semi-harmonic relations, as guided by a *musical master code*, creating an overwhelming symphony that we experience as a vivid dream of a concealed reality. Humans, in this respect, are not only observers but also active participants in this cosmic endeavor: the evolution of conscious entities have been woven into the cosmic code from the beginning. We hold that *the ZPE/SFQS domain is instrumental in these events and that we may, for the first time, have identified, at least a part, of its EMF frequencies*. These resonance patterns may also represent a pilot wave aspect of the “hidden” implicate order as proposed long ago by Bohm and De Broglie. In this sense we also touched upon, what is called, the “Hard problem” of consciousness studies of **Chalmers, 1995**, since our model, apart from the aspects of Chalmer’s (relatively) “Easy problem” of neurological/behavior correlations, the present study also treats the “Hard problem” aspect through its considerations on mind/matter relations and the potential origin of qualia. The present model also highlights the basic notions of top-down causation and potential retrocausal quantum influences on life processes.

Here our journey into deeper levels of the fabric of reality ends, at least for now, yet we will remember the wide vistas and beautiful horizons exposed to our exploring eyes: will we ever oversee the splendid integral landscape so secretly hidden from us by nature?

The late John Wheeler (revisited by the first author, **Meijer, 2015**), expressed all this with his famous prophesy of hope:

*"Someday we'll understand the whole thing as one single marvelous vision, that will seem so overwhelmingly simple and beautiful that we may say to each other: 'Oh, how could we have been so stupid for so long? How could it have been otherwise!'"*

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