Consciousness in the Universe is Tuned by a Musical Master Code. Part 1: A Conformal Mental Attribute of Reality.

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Part 1 of 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 coherently structured water is treated in relation to the generation of a primordial biofield, that is 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. We propose, therefore, that the pro-life EM frequency bands, identified in our earlier 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. Such "tonal" projections, in a global manner, may organize synchronicity, both spatially and temporally in essential organs in the body (heart and brain). In a cosmological context, we envision a scale invariant information processing, operating through a toroidal/wormhole mediated information flux. This implies an intrinsic cosmic connectivity that is mirrored in the human brain.

Key Words: Musical master code, Life algorithm, novel biophysical principle, coherent EM-scale, solitons and polarons, bio-solitons, coherent electromagnetic frequencies, beneficial and detrimental frequencies, meta-analysis of bio-medical literature, phyllosilicates, clay nano-materials, morphogenetic resonance, non-thermal EM fields, anti-cancer therapy, first life in biological evolution, quantum entanglement, Fröhlich, Einstein-Podolsky-Rosen, Bohm

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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, (1968) postulated that the potential answer could lie in coherency of wave information, while Fritz-Albert Popp, (1994) following the work of Gurwitch (Beloussov 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) (Fig. 1). Much later Stephen Hawking, (1988) proclaimed: everything that matters in the universe is electro-magnetic field activity. The force field idea reached back to David Bohm, (1952) 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 Wilzcek, (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.*

2.1 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, 2016a,b, 2017a, 2018c). 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,b; 2017a; 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 (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).

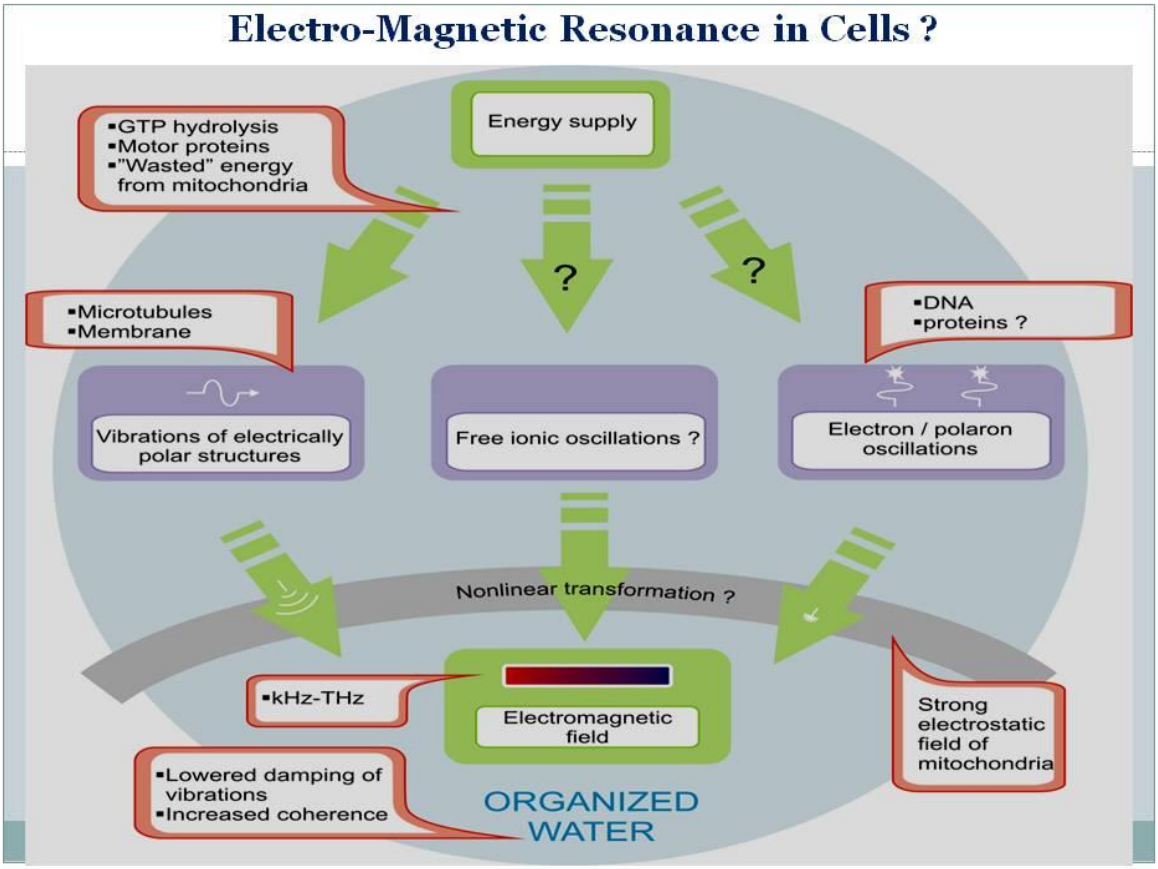

Figure 1: EMF-resonance in various organelles in the cell results from internal energy sources and/or exposure to external EMF radiation. Through coherence of wave information, (Meijer and Geesink, 2019), local EM fields may arise mediated by organized water domains on different cellular levels, (De 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 √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:

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

(E_n: Energy distribution, ω_{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)

The complete range of EM frequencies lying between 0.2 Hz to 500 THz, (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.

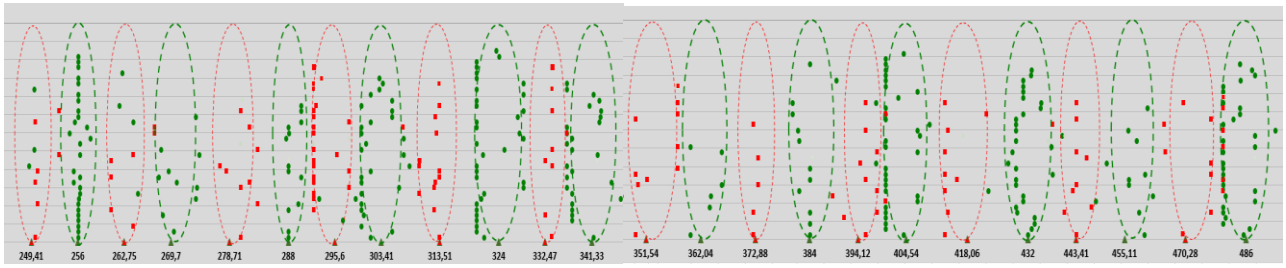

Figure 2. Measured frequency data of living cell systems that are life-sustaining (green points) and detrimental for life (in red squares) versus calculated normalized frequencies. Biological effects were measured following exposures or endogenous effects of living cells in vitro and in vivo, at a spectrum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

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-Herz 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? (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 frequency patterns that influence cancer, promote entanglement in EPR studies, in addition mirror energy distribution of elementary particles of the Standard model, and correspond to energy gaps in superconducting materials while recently in EMF absorption frequencies of pure water were analyzed (Table 1). Without exception, these studies demonstrated a striking fit with the coherent GM-scale, as revealed by us.

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

Animate systems	***Non-animate systems***
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 vibratory 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
I R-spectra of proteins, lipids, DNA (10)	

In brackets (nr.): References 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.
*= EMF frequency values that are extracted from supporting international literature:
*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 phyllosilicate (clay) materials, albumin and nucleotides in aqueous solution, as well as for a candidate RNA-catalyst (Table 1).All this indicated to us that also inanimate physical systems exhibit quantized electromagnetic features. These are based on standing waves resulting from constructive wave interference and clearly show the particular discrete pattern of EM frequencies.

The collective evidence, presented above, indicates that quantum phenomena such as coherence, entanglement and superconductivity may not only be considered as prerequisites for life, but that a similar EMF- frequency pattern may operate in some non-animated physical materials that are associated with life conditions. It should be realized here also that all life material is build up from elementary particles.

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 (Huelga et al, 2013; Lambert et al, 2013; Lloyd, 2017; Marais, 2018). Essential macromolecules of life 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,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 Geeesink, 2018).

This biofield concept is 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 (Bishof 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, as well as superconductor conditions and elementary particles) all can be modeled by toroidal geometry, (including knot theory), as shown by us in various 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,), as treated in parts 2 and 3 of this review.

Among others, 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 in part 2 and 3 that an implicate order, as proposed by David Bohm, finds it 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 (Fig.13). Our studies may therefore 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 functional configuration in less than 1 sec (Melkikh and Meijer, 2018).

Hydrophobicity-hydrophilicity models and random search mechanism, in our opinion,

cannot explain folding to the 3-D functional form, as it occurs in the intact cell (Fig. 4). 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.

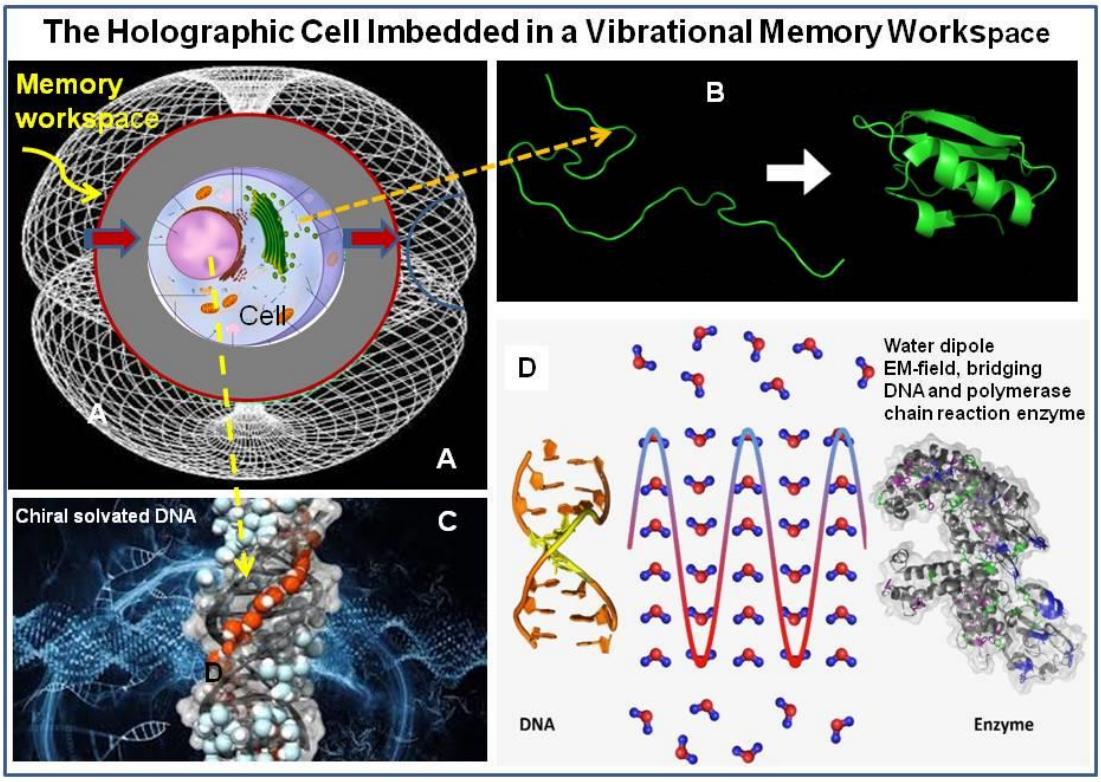

Figure 3: The life cell in a toroidal setting showing a holographic memory workspace called event horizon, that contains information for cell function and survival in the particular environment (A, upper inset left), guiding 3-D protein folding (B), wave resonance of DNA with associated water (C). Structured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

This process is pictured as being influenced by long-distance polaron/soliton vibration patterns as well as by holographic memory of integrated cell function (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 patters. Reversing this 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-code 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 occurs in a 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).

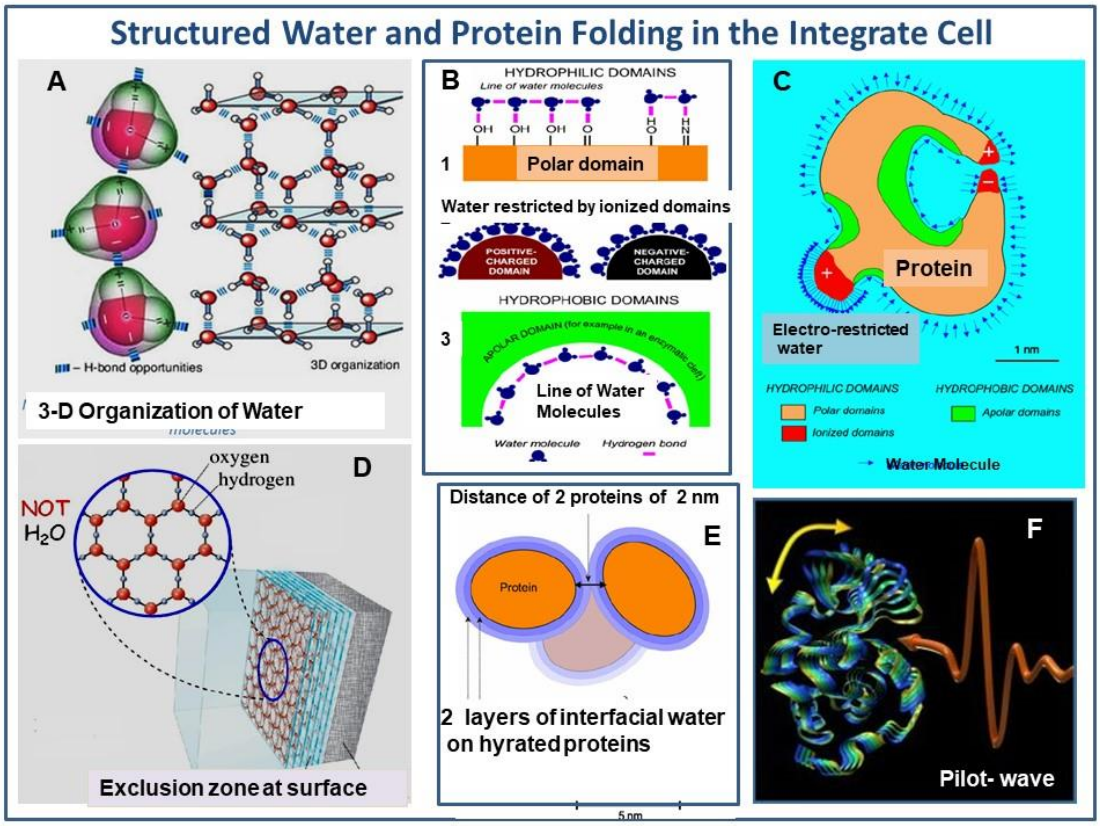

Figure 4: Hexagonal oriented assemblies of dipole water molecules (A and D), structured interfacial waterlayers at protein molecular surfaces (exclusion zones) as influenced by relative hydrophobic and hydrophilic domains (B, C, E) leading to hydrated proteins that can undergo resonant vibrations through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

Out meta-analysis of the data of different superconductors gap/frequencies from 1981 to 2018 (Geesink and Meijer, 2019a) revealed that the reported values can be positioned on the known 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; 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 patterned feature of these processes can finally lead to the design of promising high temperature conductor (HTSC)-systems. That is, if fully guided by coherent wave domains, that can be described by toroidal geometry and numerically expressed by the reveald GM-scale frequency pattern.

This technology implies that by phonon- or photon lasing with the proper combination of coherent wave frequencies, decoherence could be suppressed, leading to more stable pointer states. Apart from the dominant influence of coherency in HTC superconductivity, interestingly decoherent conditions may also play a decisive role. This may take place by matrix disturbances (vibrations) that can 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). The adding of general noise may promote the formation of polaron and polariton quasi-particles that can be instrumental in Cooper-pair electron formation, supposed to be essential for superconductive conditions.

Turner and Notalle (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 all 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 in the superconductor behaviour of hydrated protons in aqueous brain compartments as proposed by us (see section 7 in part 2).

Turner and Notalle hypothesized that the development of nano-structured materials analogous to those found in biological systems, should also promote the design of novel HTC-materials with even higher critical temperatures, This idea very much supports our view on similarities between discrete frequency patterns in both superconductor and life systems as found in our recent study (Geesink and Meijer, 2019a).

In relation to this, we proposed, therefore, to apply semi-conductive smectites (phyllosilicates), (see section 6.2), that, at exposure to light radiate GM-like EMF frequencies. in combination with HTC-superconductor materials, to further improve superconductive properties as a modality of intrinsic quantum lasing. Realizing the currently developed laser technologies, that cover the entire EMF-spectrum, as well as the striking excitation/radiation semi-conductive features of smectites, such materials 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 aspect 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 (Geesink and Meijer, 2019a).

2.6 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 (Plankar et al., 2012; Jerman 2016) 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, 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 μ (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 super-domains, 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. (Meijer and Geesink, 2018b).

2.7 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 inherent 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 x 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 basic feature is also important for the cosmic creation life, since water is seen as a fundamental substance for organizing biochemical processes in the proper planetary context (Jerman, 2016; Bishof and Del Giudice,2013; Arani et al., 1995; Del Giudice et al., 2005, 2010, Carniello et al, 2015).

As stated before, energy is constantly produced in the cell and this energy can be 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 may represent a part of the total ZPE spectrum. The embedding of life systems in this field can in principle excite all cell components by a resonance mechanism. As treated earlier, long distance soliton-mediated influence on protein folding as described by us, may be 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 shown to be clearly manifest in meso-tropic 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 indeed influence interfacial layers on macromolecules such as proteins an DNA. Such an effect was modeled by Sen e 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 *externa*l energetic EMF influences. Turner, (2016, 2019 and personal communication), suggested that all molecules in the cell drive 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. This, likely, is organized 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-like 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, amino-acid sequence, spatial configuration, molecular distribution of charges and internal hydrophobic interactions, that determine final 3-D folding etc. Within the cell, the final 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 intrinsic or exteral coherent EMF GM- photon frequencies and, in contrast, be disturbed by the decoherent ones (Fig. 2). In the material state, such photon activity can be rather become manifest in 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 in the protein backbone, can perturbate the overall folding of the macromolecule.

The collective, cell oscillatory, matrix is in turn physically connected at long-distance with other parts of the organism either through quantum superposition and entanglement or local synchronized oscillation modalities. These long-range connective aspects may also enable non-local permanent pattern imprinting of molecular vibration in the water-layer structure of adjacent cells. Such collective vibratory states, tentatively, 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) (Fig.3).

Spectroscopic measurement of oscillation frequencies of individual proteins in aqueous solution therefore can, in principle, both show GM-scale *coherent* frequency values and *de-coherent* values, depending on the overall vibrational state of the multiple molecules dissolved in cell water. 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 coherent conditions into decoherent ones 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. Clearly, the position of this poised equilibrium state may undergo influence by intrinsic ZPE- field 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-Herz frequency 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).

In conclusion to this section we claim that the cell and its components are always under the influence of locally active wave fields of internally ATP induced EM oscillations and can at the same time be 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 (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 photon region and perfectly fit the GM-scale frequency pattern (Geesink, Jerman and Meijer, 2019). Possibly, such typical water properties can be applied for defining appropriate biomarkers for diagnosis of healthy and diseased states, as was researched in the field of aquaphotomics (Tsenkova, 2018).

3.1 Torus Operators Mediate Information Flux in a Super-Fluid Quantum Space by forming a Wormhole Communication Network

Some of our previously discussed 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. Clearly, this spectrum of elements can be seen as being 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). Both Haramein and Carr (Haramein at al., 2016; 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 in part 2 of this review).

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 Malcadena, (2016); Baez and Vicary (2014) and Haramein et al. (2016), who independently postulated that both the entities of space and time can be fundamentally described by assuming that entangled particles are connected through wormhole entities (Einstein-Rosen bridges). This idea provided 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 in nature 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.7, 8, 13 in part 2 of the review).

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 (Bishof 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). Superconductive 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; Haramein 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, 2018b), 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, 2018c) (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. Thereby it creates new patterns and behaviors that registers these adjustments and in turn informs the living system as a whole (see further in section 6). We hold that the recurrent process that underlies this process can also be modelled by

toroidal geometry (Fig. 5 and in part 2 fig. 7). 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 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. 8, in part 2). Thus, the synergetics of torus geometry and recurrent toroidal energy flow patterns seems to be fundamental to all cosmic creation (Lefferts, 2019).

3.2 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: $En= nh\omega = nh/T$, discretized angular frequencies: nω, and time periodicity $T = h/E$). According to '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 Hiliey,1983, Bohm and Peat 2008) as discussed by us in (Geesink and Meijer, 2018b, c).

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 (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 present in an exact integer ratio. In reality, the sound speed is not constant, but the Eigenfrequencies found are expressed in a harmonic 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, such 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 patterned 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).

3.3 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. There are several reasons for considering fermions and other particles as superfluid vortices of SQ.

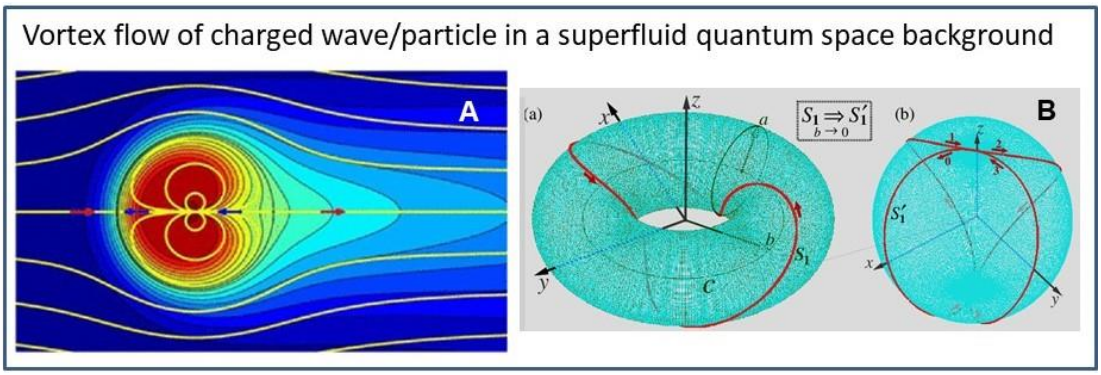

Figure 5. A: Steady vortex avenue confined by transfer flow with a dipole source inside and a uniform background flow outside. Yellow streamlines outside of the vortex area represent possible Bohmian trajectories B: Transformations of torus shown in (a) to the tori when the radius b tends to the radius 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.

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 (2012, 2017) considers quantum vacuum as a superfluid and applies quantum considerations to Navier-Stokes equations (see section 7 in part 2).

Sbitnev describes vortex objects (vortex balls) that, unlike Hill's spherical vortices, show intersected streamlines (Fig. 5) 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 this 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, 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 spin½, necessary to describe fermions. Indeed, the system would return in a given state after a rotation of 720°. 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 ψ_n of photon, expressed as $E_n = (n + 1/_2)\, k\omega$

[1] $k\omega$ is vacuum (SQS) contribution, as well as for a phonon, where the harmonic oscillator eigenvalues for the mode ω_k (k wave number) are $E_n = (n + 1/_2)\, k\omega_k \qquad n = 0, 1, 2, 3, \ldots$

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,
- 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

Tus, 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.

In 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 in embedded.*

4. 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 Chladni (Rossing, 1982), as well as the cymatics of Jenny (1974) as well as Waller (1955), in which sounds create, clearly, mathematically defined distribution patterns of fragmented material on a flexible surface (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 (fig. 6 c), 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 (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" (Fig. 6). 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 (Fig. 6c) 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. 6c).

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.

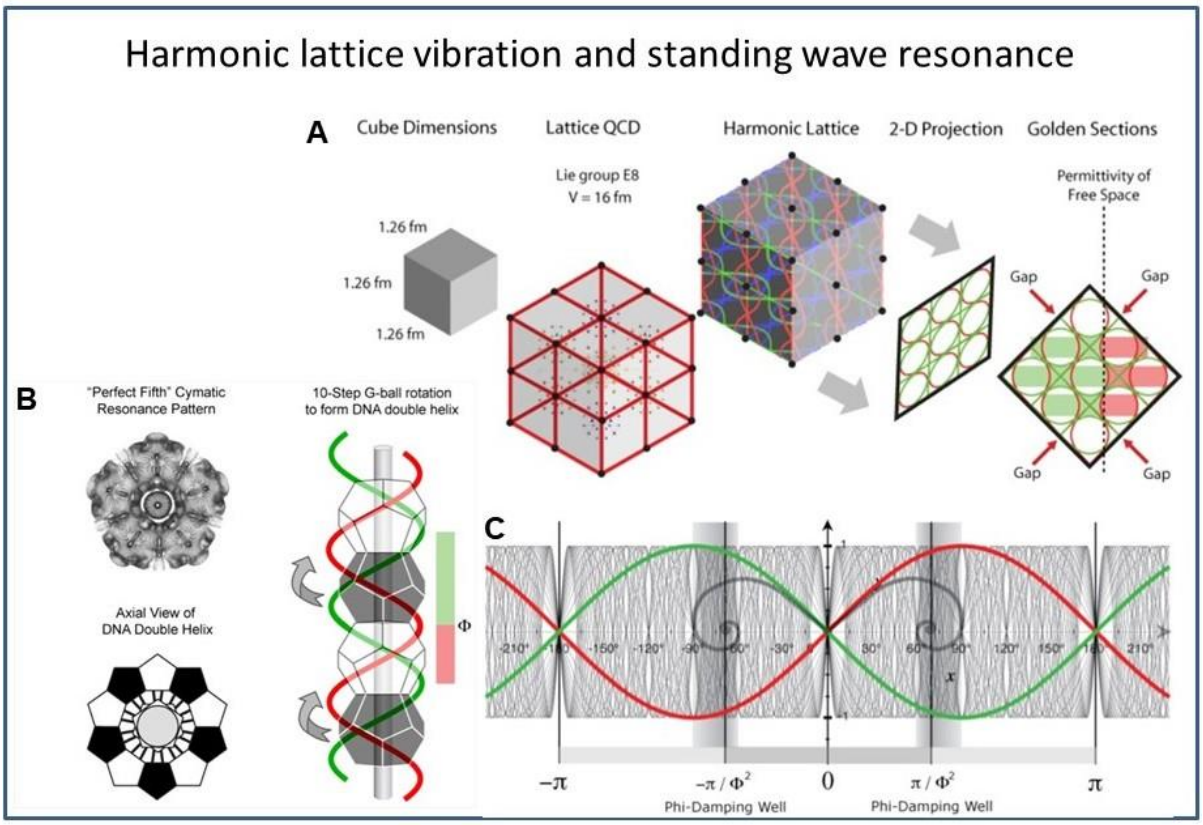

Figure 6. A: Permittivity of free space as a function of the golden ratio. **B**: DNA double helix modeled as G- ball dodecahedron resonating up around a central axis. **C:** Harmonic standing wave sharing energy inside Phi-damping, that provides the very separation of notes.

Sanya et al, (2016), stated that 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,* yet 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 the 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 Chladni, like some of us also did 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 (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 in part 2).

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 (Attasoy et al, 2018). Such "tonal" projections 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 e al., 2018, Sahu er 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 microtubules 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.

The authors suggest that this mechanism operates 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 2.4). 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, a geometric information that finally become expressed in 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 that *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 (section 6).

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 (Van de Bogart, 2019). Now we indeed see the growing importance of *acoustic cosmology* (Handler, 2012; Stark, 2017) that is manifest on the macro-scale in a plasma universe (Peratt, 2013). On the micro-scale there is a 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 microtubules in the group of Anirban Bandyopadhyay (Agrawal et al, 2016, 2017; Sahu et al. 2013, 2015;), DNA (Savelyev, 2019a,b), 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 valid 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).

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