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Is the Fabric of Reality Guided by a Semi-Harmonic, Toroidal Background Field?

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Abstract

In this mini-review we describe our recent work, summarizing 13 publications, integrating their concepts and picturing potential perspectives. The history of the discovery of the generalized music (GM)-scale is highlighted in relation to the areas of bio-field research and quantum biology. The central message is that nature may be guided by a discrete pattern of electromagnetic frequencies, as expressed in photon/electron (polariton) and phonon/electron (polaron or soliton) activities. This guiding is based upon a physical coherence principle that is coupled to entanglement, acts in a local and non-local way, and is embedded in a toroidal geometry. We performed meta-analysis studies on biomedical, cancer and neurological literature, revealing the discrete EMF frequency pattern in a consistent manner. This novel biophysical principle exhibits a mathematical background and was also applied to brain function (consciousness research) and 3-dimensional protein folding in integrates cells. Strikingly, this life algorithm could also be detected in various non-animate systems. Among others we discovered a very similar pattern such as energy/frequency distributions in entanglement (EPR) experiments, frequencies of the currently known elementary particles in the standard model as well as in frequency patterns of spectral energy gaps that promote superconducting properties. The latter aspect provides an interesting bridge between life systems and pure physical phenomena. Finally some potential applications in quantum computing and health technology are treated on the basis of a toroidal model approach.

Keywords: Quantum biology; Biophysics; Quantum computing; Macroscopic coherence; Generalized music (GM) scale; Protein folding; Brain function; Consciousness studies; Solitons; Polarons; Polaritons; Toroidal modeling; Preventive health technology; Cancer therapy; EMF and Neurological disorders; EPR experiments; Mass/energy distribution of elementary particles; Superconductors at high temperature

Introduction

The Discovery of a Semi-harmonic EM Spectrum in Life Systems

A biophysical basis for spectrum of discrete electromagnetic field (EMF) frequencies that were shown to affect health and disease [1, 2, 3, 4], were elaborated and generalized [4]. The particular EMF pattern was earlier revealed by us through a meta-analysis of more than 500 biomedical publications that reported life-sustaining as well as life-decaying EMF frequencies. The detected Eigen-frequencies could be arithmetically scaled according to a corresponding music theory, based on an adapted Pythagorean tuning. The particular semi-harmonic scale exhibits a core pattern of twelve Eigen frequency functions (Figure 1), with adjacent self-similar patterns, according to octave hierarchy [1, 2, 3, 4 and 7]. It should be realized that this frequency pattern reflects experiments in which the life systems were exposed to *external* EMF radiations, as well as influenced by the presence of endogenous 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 1-4]. Our studies should be seen in the light of the rapid expanding areas of Biofield Research, adequately reviewed in [14-17], as well as that of Quantum Biology [18- 23].

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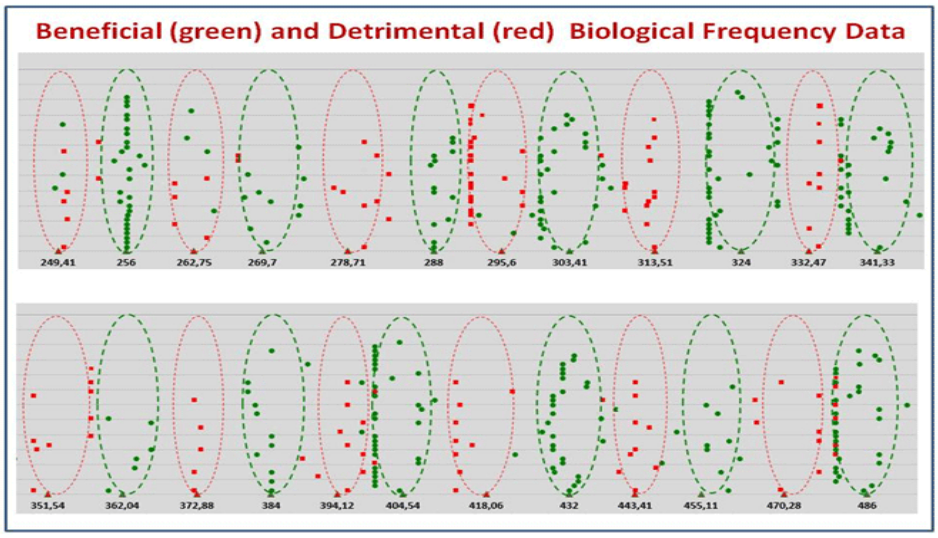

Figure 1: Measured frequency data of living cells systems that are life-sustaining (green points) and detrimental for life (in red squares) versus calculated normalized frequencies. Biological effects measured following exposures or endogenous effects of living cells in vitro and in vivo at frequencies 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 Mathematical Basis for a Generalized Music Algorithm

A more detailed mathematical analysis [7] shows that the derived arithmetical scale exhibits a sequence of unique products of integer powers of 2, 3 and a factor √2. These discrete Eigen frequency 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:

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

(En : Energy distribution, ω_{ref} : Reference frequency 1 Hz, ħ : 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, see ref. [1], on basis of the 12 core frequencies, depicted in Figure 1, can be easily expanded in lower and higher frequency values by multiplication or division by a factor 2. This provides an octave hierarchy of self-similar extensions of the scale. One informative example is the calculation of the vibration frequency of water from the known Einstein/Planck equations E= mc^2 and E=h.v. In the case of the H_2O molecule with an M of 18, and knowing the values of speed of light c and the Planck constant h, a water-specific frequency can be calculated in Hz. 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 (see Figure 3). It is of interest that the boundaries of this frequency spectrum lie in the far-infrared EM region that occupies a middle ground between microwaves and infrared light waves, known as the "terahertz gap". It represents the region in the electromagnetic spectrum where the frequency of electromagnetic radiation becomes too high to be measured digitally via electronic counters, so must be measured by proxy using the properties of wavelength and energy. In quantum many-body systems, several of the relevant states have an energy difference that matches with the energy of a THz photon. THz field's photon energy plays also a role in semi- and superconducting phases because it can be resonant with several quantum many-body transitions [13].

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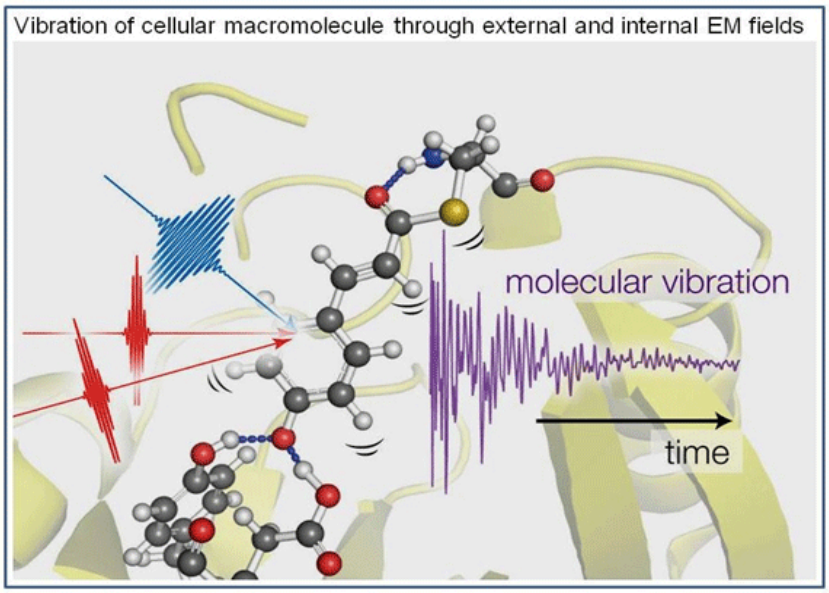

Figure 2: Short and long distance guiding of macromolecular structures in the cell by internal EMF wave frequencies (red) and external EMF scattered energies (blue). Discrete molecular vibrations in coherent domains in the cell can obtain a resonant state that is instrumental in intra- and intercellular communication and information processing in time.

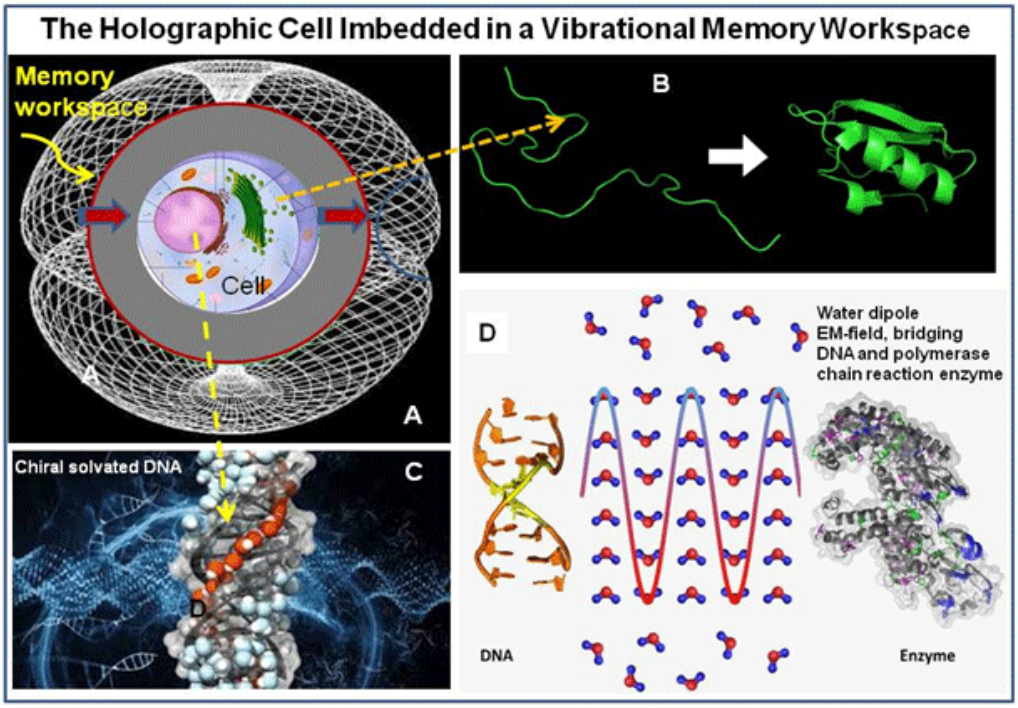

Figure 3: Toroidal hypersphere mediated morphogenesis of the integral cell. A: The nested torus structure with an outer surface of the torus (red circle and arrows) represents the event horizon memory space surrounding the cell. B: depicts the 3-D folding of life macromolecules as it occurs following primary synthesis in the cell. C: shows the fractal attractor structure of H_2O around DNA, steered by quantum information of the toroidal hypersphere memory workspace, D: Shows the dipole radiative EM field of arranged water molecules that bridges the DNA molecule and PCR enzyme as essential for realization of the PCR activity. The coherency of cytoplasmic domains may be steered by externally applied EM fields in a resonance state with the various cellular vibratory elements (modified from Montagnier, see [11]).

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The GM-principle is operating in animate and Non-animate Systems

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).

Of note, the calculated standing wave values of sound-induced vibrations evoked on thin vibrating membranes, as reported in the previous century by Chladny, also are congruent with the GM-scale [1, 2]. This collective evidence, thus, points at a generalized biophysical algorithm underlying complexity in nature, evidently manifest in both animate and non-animate modalities. It was therefore coined by us the generalized musical (GM) principle [reviewed in 5]. The particular semi-harmonic frequency spectrum may reflect a discrete pilot-wave structure that can be interpreted as a, so called, hidden variable in Bohm's causal interpretation of quantum field theory [7], as described by Bohm [47, 48] and as further adequately discussed by Sarfatti [54].

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

Animate systems	**Non-animate systems**
Biomedical research, 500 papers	Energy distribution in EPR-experiments, 40 papers
Cancer research, 219 papers	Energy distribution elementary particles, 40 papers
Neurological studies, 24 papers	Coherence promotion in superconductors, 80 papers
Nucleotide and albumin resonances	Coherent sound induced vibration patterns, 6 papers
RNA synthesis catalysis	Phyllosilicate semi-conductor materials
Brain function and Consciousness? *	Zero point energy of elements?
Protein folding in intact cells?	Gravitational waves?
Super conduction in life systems?	Plasma waves in noble gasses?
*Question mark indicates: preliminary results, under investigation	

Brain function and consciousness studies

The GM-biophysical principle was also applied to the areas of modeling brain function related to human consciousness [2] [6], as treated earlier in major reviews [31-39]. In this study, the brain was conceived to be embedded in a holographic structured field that interacts with resonant sensitive structures in the various cell types in our body. In order to explain earlier reported ultra-rapid brain responses and effective operation of the meta-stable neural system, a field-receptive mental workspace was proposed to be communicating with the brain. Among others, it is integrating discrete patterns of Eigen-frequencies of photonic/solitonic waves, thereby continuously updating a time-symmetric global memory space of the individual. Its toroidal organization may allow the coupling of gravitational, dark energy, zero-point energy field (ZPE) as well as earth magnetic fields energies (Figure. 4) and may transmit wave information into brain tissue, that thereby is instrumental in high speed conscious and sub-conscious information processing. It was proposed that the supposed field-receptive workspace, in a mutual interaction with the whole nervous system, generates self-consciousness and is conceived as operating from a 4th spatial dimension (hyper-sphere). The torus that is envisioned as a basic unit (operator) of space-time is seen as instrumental in collecting the proposed pattern of discrete GM-frequencies that provided an algorithm for coherent life processes. It is postulated that consciousness in the entire universe arises through, scale invariant, nested toroidal coupling of various energy fields, that may include quantum error correction.

In the brain of the human species, this takes the form of the proposed holographic workspace, that collects active information in a "brain event horizon", representing 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 network synchronicity, as required for conscious states. In relation to its scale-invariant global character, support was found for a universal (cosmic) information matrix. The presence of a field-receptive resonant workspace, associated with, but not reducible to, our brain, may provide an interpretation framework for widely reported, but poorly understood transpersonal conscious states[6] and algorithmic origin of life[11, 12]. It also points out the deep connection of mankind with the cosmos and our major responsibility for the future of our planet.

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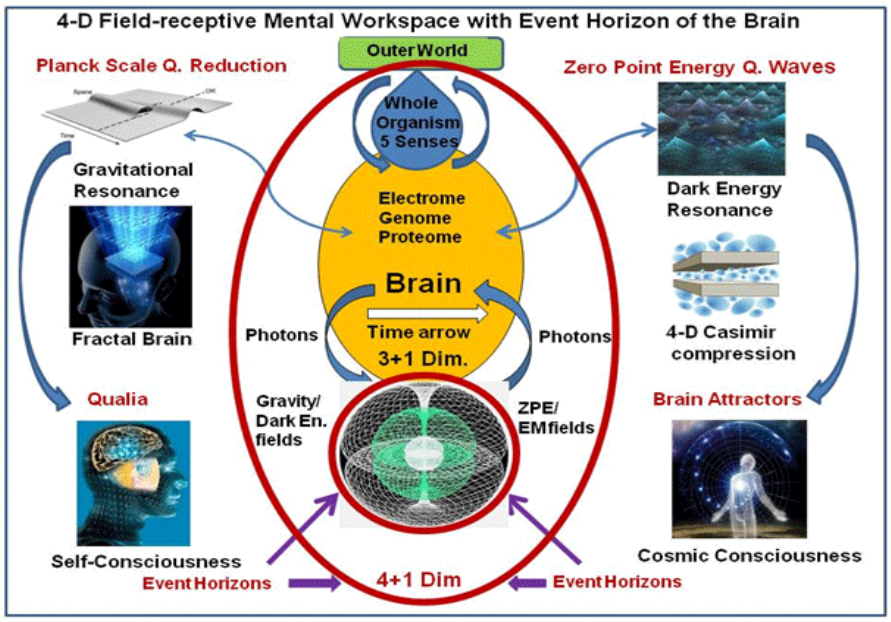

Figure 4: Modeling of brain/mind relation in a 4+1-dimensional space-time framework (4+1 implies 4 spatial dimensions and one single dimension of time), on the basis of energy trajectories in a nested toroidal geometry. The opposing forces of Dark energy (diverging force) and Gravity (converging force) 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 a 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 4th 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 4th spatial dimensions is also assumed to accommodate the bidirectional flow of information between the domains of self-consciousness and universal consciousness. Bottom-up information flow from the Planck scale, combined with top-down information conjugation from the ZPE field, constitute the event horizon of the brain, also integrating gravitational and dark energy related force fields, and supervenes the physical brain. Event horizons of brain and whole body are depicted in red ellipse and circle respectively.

EM Fields and Neoplastic Diseases

A recent publication of the authors in the Journal of Cancer Therapy [8], dealing with EMF and cancer, provides a comprehensive overview of electromagnetic (EM) frequencies that influence cancer processes and examines the bio-molecular and biophysical mechanisms that may play a role in the wide-spectrum of tumor etiologies. The study finds discrete bands of EM frequencies that correlate with cancer suppression as well as discrete frequency ranges that promote neoplasm formation (Figure 5). As described in the paper, "carcinogenesis fits in a frequency pattern of EM waves in which a gradual loss of cellular organization occurs". The coherent EM field frequencies are named such because of their beneficial affect on the biological system, whereby it appears that their constructive resonance with macromolecules in the cellular system stabilize and even reverse abnormal functioning, like that seen in neoplasm's.

The coherent EM field frequencies stimulate beneficial solitons/polarons energies, which have been shown to be involved in macromolecular and cellular signaling and are related to the mechanism of "Fröhlich condensation", first hypothesized by physicist Herbert Fröhlich [1, 14-17]. In this process vibrational energy is concentrated in the lowest-frequency vibrational mode, inducing strong quantum coherence of bio-molecules (Figure 2) similar to the formation of Bose-Einstein condensation as also related to superconductivity. The coherent EM field frequencies are thus hypothesized to promote the formation of such strong quantum coherences, increasing the strength and fidelity of intra- and inter-cellular signaling. In this process coherent oscillating domains of ordered water molecules in resonance with other macromolecules are supposed to play a central role [18-23 and 40- 43] and Figure 3.

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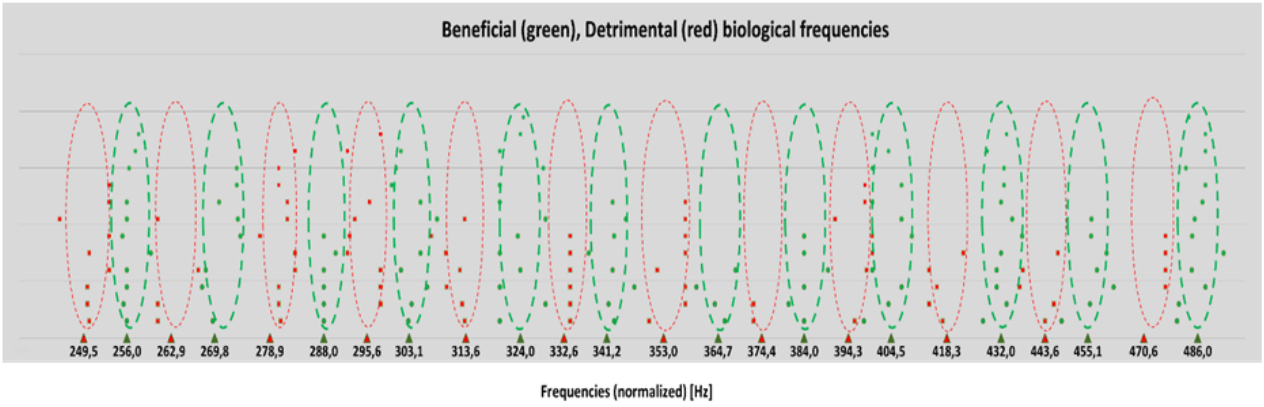

Figure 5: EMF frequencies, related to cancer-research, that were experimentally applied to living cells systems reported in 219 separate biomedical studies, plotted on a semi-harmonic logarithmic reference GM-scale, are found to be patterned in 12 apparent bands of in total 143 life-sustaining **coherent** frequencies (green points) and 77 cell-destabilizing **non-coherent** frequencies (red squares). The latter are clearly positioned between the life-sustaining frequency bands. Each point indicated in the graph represents an individual experiment. For clarity, points are evenly distributed along the Y-axis, according to the number of experiments within each apparent frequency band.

3-D Functional Protein Folding in Integrate Cells

The Fröhlich/Davydov concept [40-43] on soliton influence on protein vibration has been elaborated and further improved by Pang [41], taking into account that solitons can be largely stabilized, and their life-time increased due to mutual interaction of the particles with lattice vibrations. Consequently the total state of the system has been expressed in three different Hamiltonians. Due to these extensions, the solitons obtain life-times that are more compatible with the ruling biological conditions. This was expressed in Hamiltonians on quasi-coherent two-quantum state wave function [41]. According to the mechanism of bio-energy transport Davydov established the theory of bio-energy transport in protein molecules, in which he gave the Hamiltonian of the protein molecules:

Equation 1a:

$$H_D = \sum_n [\varepsilon_0 B_n^+ B_n - J(B_n^+ B_n + B_n B_n^+)] + \sum_n [\frac{p_n^2}{2M} + \frac{1}{2} w(u_n - u_{n-1})^2] + \sum_n [\chi_1 (u_{n+1} - u_{n-1}) B_n^+ B_n] = H_{ex} + H_{ph} + H_{\text{int}}$$

B is the creation (annihilation) operator for an Amide I quantum (exciton) in the site n, un is the displacement operator of amino acid residue at site n, Pn is its conjugate momentum, M is the mass of an amino acid molecule, w is the elastic constant of the protein molecular chain, N is a nonlinear coupling parameter and represents the size of the exciton-phonon interaction in this process, J is the dipole-dipole interaction energy between neighbouring amino acid molecules, m is the average distance between the neighbouring amino acid molecules. The wave function of the system proposed by Davydov has the form of:

Equation 1b:

$$D_2(t) = |\varphi_D\rangle |\beta(t)\rangle = \sum_n \varphi_n(t) B_n^+ \exp\{-\frac{i}{\hbar} \sum_n [\beta_n(t) P_n - \pi_n(t) u_n]\} |0\rangle$$

Pang has added a new coupling interaction of the excitons with the displacement of amino acid molecules into the Hamiltonian and replaced further the Davydov's wave function of the one-quantum (exciton) excited state by a quasi-coherent two-quantum state. The representations in equations (1a) and (1b) for the single-channel protein molecules are replaced by:

Equation 2a:

$$H = H_{ex} + H_{ph} + H_{\text{int}} = \sum_n [\varepsilon_0 B_n^+ B_n - J(B_n^+ B_n + B_n B_n^+)] + \sum_n [\frac{p_n^2}{2M} + \frac{1}{2} w(u_n - u_{n-1})^2] + \sum_n [\chi_1 (u_{n+1} - u_{n-1}) B_n^+ B_n + \chi_2 (u_{n+1} - u_n)(B_{n+1}^+ B_n + B_n^+ B_{n+1})]$$

Equation 2b:

$$|\Phi(t)\rangle = |\alpha(t)\rangle |\beta(t)\rangle = \frac{1}{\lambda}[1 + \sum_n \alpha_n(t) B_n^+ + \frac{1}{2!}(\sum_n \alpha_n(t) B_b^2)^2] |0\rangle_{ex} \times \exp\{-\frac{i}{\hbar} \sum_n [\beta_n(t) P_n - \pi_n u_n |0\rangle_{ph}$$

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.

Recently, the potential long range resonant influence was further worked out in a study of 3-dimensional protein folding in the intact cell [11] that can be largely influenced by the formation of coherent oscillation domains in the cell water interacting with the protein backbone (Figure 2 and 3). We argued 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 [12]. Hydrophobicity-hydrophilicity models and random search mechanism cannot explain folding to the 3-D functional form, as it occurs in the intact

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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 [11, 12]. In this concept the protein molecule is influenced by various long and short distance force fields of nature such as coherent electromagnetic waves (Figure 3) and zero-point energy. 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, [52]) that 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.

Potential influence of Discrete EM fields in the Creation of First Life in Biological Evolution

We found previously that coherent natural and permanently operating wave pattern phenomena are present in typical selected clay minerals, that have semi-conductive like properties [1, 2 and 3]: identical EM field eigenvalues could be measured by one of us (HG) (Figure 6 and ref. [1] and [2]). Of note, these types of clay minerals are, apart from being present in soil, also abundantly suspended in the universe, including 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. It is of interest that such silicates have been reported to be candidates for the facilitation of oligo-nucleotide synthesis in the creation of first life in biological evolution [1, 2, 11, 12] and [24, 26]. The selected silicates probably act as quantum replicators, specifically emitting EM radiation at coherent frequencies in a surrounding of ordered water molecules. Such silicate quantum replicators therefore may have been instrumental in the initiation of first replicating life, cells at the edge of pre-biotic evolution [24-30].

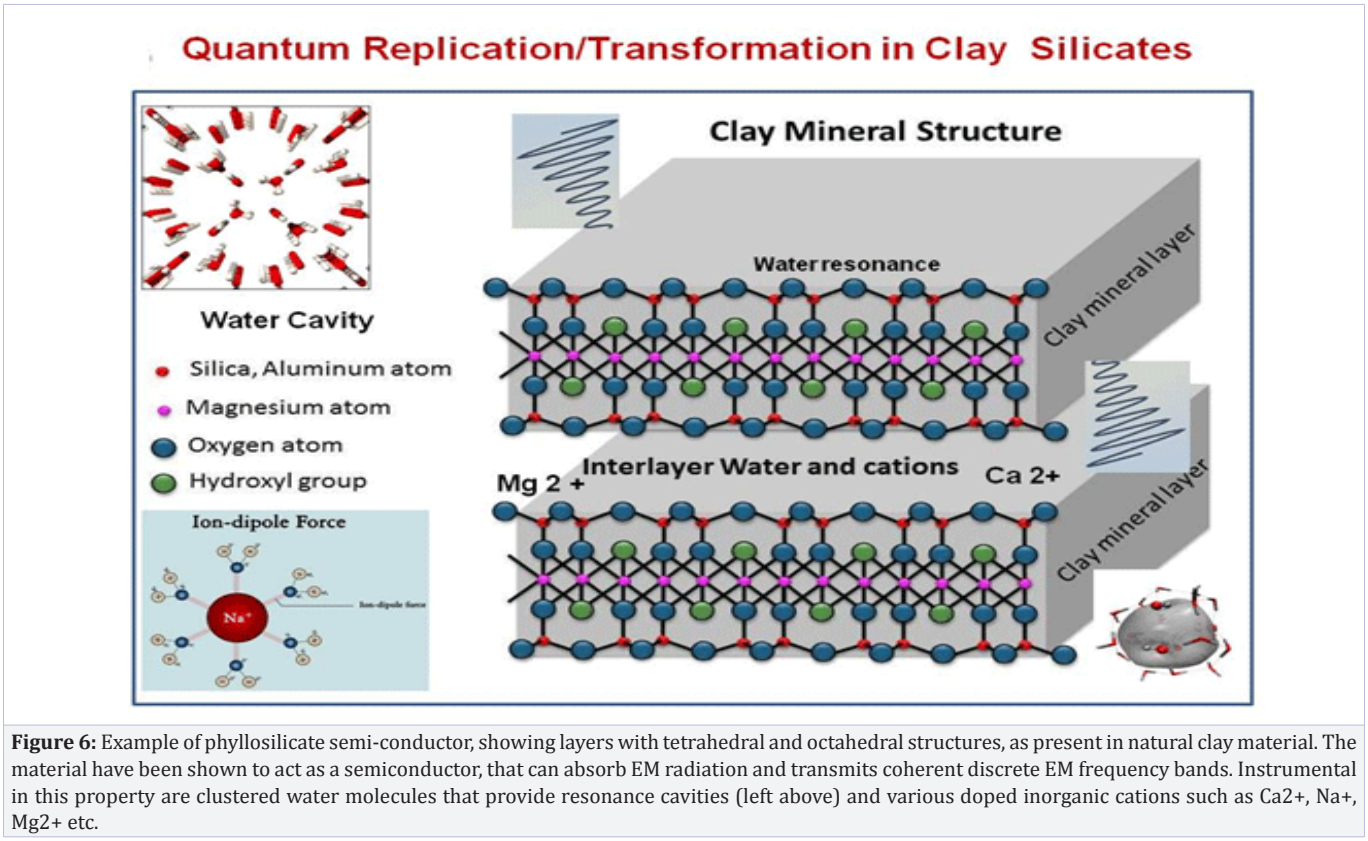

Figure 6: Example of phyllosilicate semi-conductor, showing layers with tetrahedral and octahedral structures, as present in natural clay material. The material have been shown to act as a semiconductor, that can absorb EM radiation and transmits coherent discrete EM frequency bands. Instrumental in this property are clustered water molecules that provide resonance cavities (left above) and various doped inorganic cations such as Ca2+, Na+, Mg2+ etc.

We propose therefore that a primordial biological principle (register of rules) was operating, that acts as a "recipe for life" [12]. This type of a-priory information could have preceded the development of first life and all known force fields that were present from the birth of the universe should be taken into account (as mentioned earlier). Also 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 [18, 30, 25, 27]. This in addition to lattice type of organization of dipole water molecules, together forming life harmonic-like lattice resembling fluid crystals in which life can be viewed upon as a crystallized form of quantum oscillations that invites to see the cosmos as a purpose-driven incubator for life. This entire process was also depicted as a kind of "biological music" originating from a pre-

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existing universal law intrinsic to nature, and conceptualized as a toroidal alternative to random self-organization [11, 12]. Very likely syntropic (neg-entropic) wave information from the zero-point energy field [51, 54, 56], selected in resonance with the *electrome* [14] of the proto-cells played probably a crucial role in the morphogenesis and building up of functional biochemical networks during pre-bioses [36, 55].

A characteristic hallmark of life is its homochirality: all biomolecules are usually of one hand, e.g. on Earth life uses only L-amino acids for protein synthesis and not their D mirror images. Chirality is a Lorentz invariant quantity and a left-chiral particle is not transformed into a right-chiral particle by parity transformations. All fundamental interactions of elementary particles, with the exception of the weak interaction, are symmetric under parity. The weak interaction is chiral and thus provides a means for probing chirality in physics [28]. Adsorption to the chiral surface of phyllosilicates (see Figure.6) is a possible mechanism not only to generate frequencies described by the GM-scale, but also to induce a specific chiral character since parity-violating weak interactions in these crystalline, enantio-selective and possibly pre-biotic, catalysts has been found [29].

The GM-principle and Quantum Entanglement Research

In view of the current interest in coherent states and entanglement in quantum biology, we subsequently performed meta-analyses of 40 papers in physics that deal with the influence of electromagnetic frequencies on the promotion of entangled states in, so called, EPR *experiments* [9]. Einstein, Podolsky and Rosen originated the EPR-correlation thought experiment for quantum-entangled particles, in which particles are supposed to react as one body. The meta-analyses of the EPR-experiments learned that the applied frequencies are located at discrete coherent configurations. As predicted all analyzed EPR-data of the independent studies fit precisely in the derived scale of coherent frequency data and turned out to be virtually congruent with the above mentioned semi-harmonic EM-scale for living organisms. This implies that the same discrete coherent frequency pattern of EM quantum waves, that determine local and non-local states, is also applicable to biological order and may indicate that quantum entanglement is a prerequisite for life. The study may indicate that the implicate order of pilot-wave steering system, earlier postulated by David Bohm [47,48] is composed of discrete entangled EM wave modalities, related to a pervading zero-point energy information field [36, 51, 54, 55, 56].

The GM-Principle and Elementary Particles Energies of the Standard Model

In a follow-up study, the model was further applied to the data of a meta-analysis of earlier measured discrete mass/energies and related frequencies of 37 different *elementary particles,* as well as zero-point energies of elements [10].

A clear fit with the GM-frequency pattern was found (Figure 7), indicating that a semi-harmonic background underlies the quantum field theory of subatomic particles. This confirms the idea that an ontological basis of the Standard Model is at stake. These data may also indicate that the GM-scale is frequency-locked with zero-point oscillations, and thereby evidently implies involvement of entangled states. The present theory thereby combines quantum mechanics and classical periodic systems, obeys to locality and refers back to the "hidden variable theory of Bohm" [47, 48, 54]. The pattern of electromagnetic field eigenvalues, within a broad range of discrete frequencies, as revealed in the present studies, points at a de Broglie/Bohm type of causal interpretation of quantum mechanics, implying an integral resonant pilot-wave/particle modality [13]

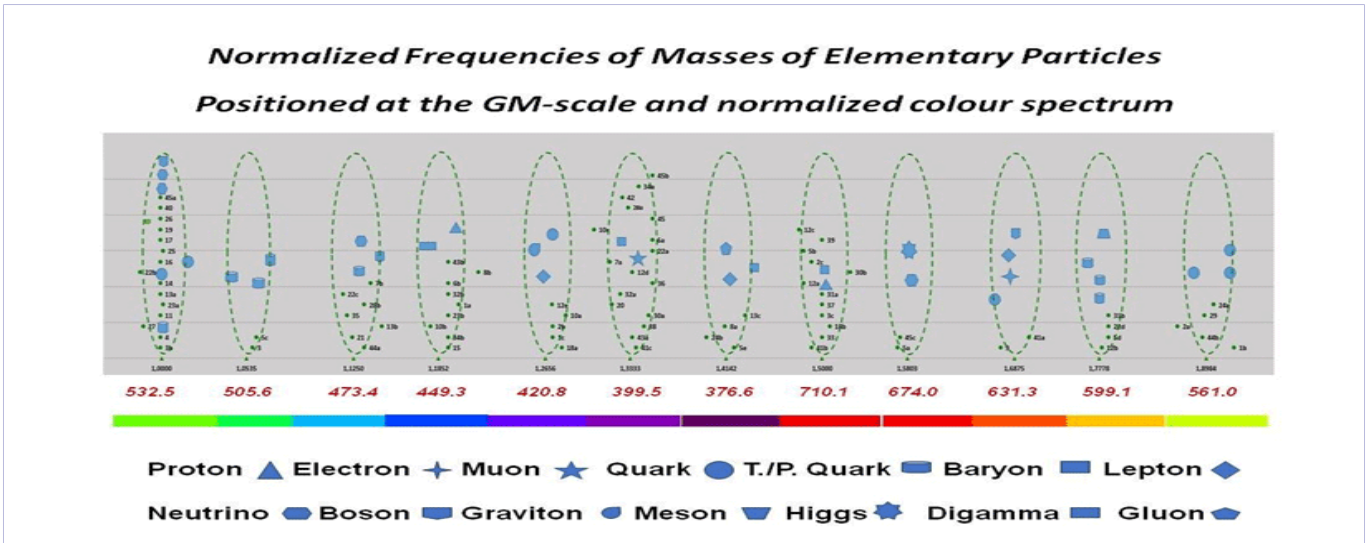

Figure 7: ENormalized frequencies of masses of Elementary Particles positioned at the GM-scale and added normalized color spectrum. Green triangles plotted on a logarithmic x-axis represent normalized coherent-frequencies. Green points: data of Einstein-Podolsky-Rosen experiments (1972-2017). Blue points represent calculated normalized frequencies of masses, (for clarity, points are distributed along the Y-axis)

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Coherence/Decoherence cycles?

It is important to note that in our life studies a regular pattern of both coherent and decoherent frequencies were found (see Figure 1). The coherent part of the GM-scale was defined by us as semi-harmonic since it is not only be based on integer numbers, as in classic harmonics, but also on rational numbers and an irrational number according to an adapted Pythagorean scale, that suggest a toroidal (rotational) aspect in the mathematical background. Importantly, only coherent and no decoherent values were detected in the purely physical studies on EPR entanglement and elementary particle studies as well as in the superconductor studies (see section on page 10). What could be the reasons that the decoherence aspect seems absent in the latter studies? Needless to say in the case of EPR and superconductors studies, this is likely to be due the selection of materials that have been made by the investigators in relation to an optimal function related to coherence and entanglement, yet in principle, not excluding decoherent frequency values. Apparently such an argument does not hold for the standard model study that clearly lacks decoherent values in the distribution of elementary particles mass/energies (see Figure 7). Combinations of coherent and decoherent states according to the GM-scale can be found in all kind of atoms/molecules, and it may be that decoherent states are created through interactions in complex structures as an implicit feature [65]. We have earlier speculated that the combination of coherent and decoherent wave frequencies in the life systems could reflect a potential regulatory mechanism [5]. Alternatively they could be related to entropy-forced repair mechanisms to remove corrupted cells from the organism by, for instance, the crucial process of cell apoptosis [4, 5].

Importantly, 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 by collapse of the wave function could in principle be a reversible process. Consequently, it would be justified to think in terms of dynamic states of coherence/decoherence in a cycling mode [20, 21], see Figure 8). 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, and thereby enabling fast responses essential for the cell ecology and survival. Also, for instance wave/particle duality may occur in a domain in which wave and particle modes are present at the same time. In fact, such a poised condition could be conceived as a thermodynamic balance between entropic and syntropic (neg-entropic) aspects of reality. In fully physical systems such opposing conditions would have a more implicit character as for instance in wave/particle duality, matter/antimatter annihilation and forces such as gravity and dark energy. All this would imply a general aspect of symmetry and/or duality in nature that even could explain other poorly understood phenomena such as life and death, conscious versus non-conscious aspects of brain function [2, 6 and Figure 8].

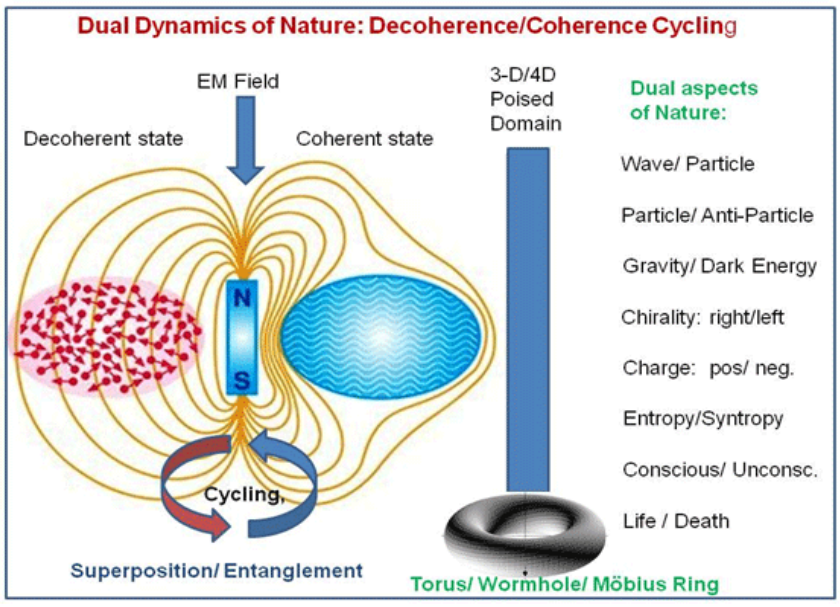

Figure 8: Hypothetical cycling of quantum coherent and decoherent states (left). Dynamic duality may play a general role in the fabric of reality (right). Middle: 3D/4D poised domain that allows choice between two quantum states in equilibrium in which all of the depicted processes may operate on the brink of 3D and 4D spacetime. Middle below: 3-D Torus can perform 3D to 4-D rotations, that can be compared by closed movement on a Möbius strip (inside is outside), which may imply restoration of non-duality. Right: Other well known dual processes in Nature.

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In fact, there are many suggestions in literature on the principles of recurrent information flux and all kind of cyclic processes in nature [6, 65]. A crucial element in these processes could be a sort of connective information flux instrumented by bosonic energies such as wave fields of photons and phonons (depending on the medium at stake). Zero-point energy could be a prominent information domain since the electromagnetic photon part can become polarized at accelerated movement of fermionic charge and in this process is known to obtain a rotational character. Quasi-particles that bear both bosonic and fermionic elements, could play a crucial role in information transfer and may have guiding potential [3-5]. Especially the topological organization of photon/phonon and electron quanta flux, as for instance in the present torus model, would be an attractive multi-cyclic mode. Of note, the torus, including its knots, is seen as an attractive model for the physical description of various elementary particles up to very large structures in the universe [6].

It is further considered that the intervals of this GM-scale can be described by a 3D toroidal space, according to the knowledge of a 12-basic coherent scales, and can be modeled, in principle, by a torus geometry, as described by Amiot [46].For example: the circle of "fifths" of the GM-scale can be positioned at rotoids (composed motions of rotations), that circles or spiralizes each sub-unit of the nested tori, together with inscribed triads, major-third and minor-third relations, see Figure 9.

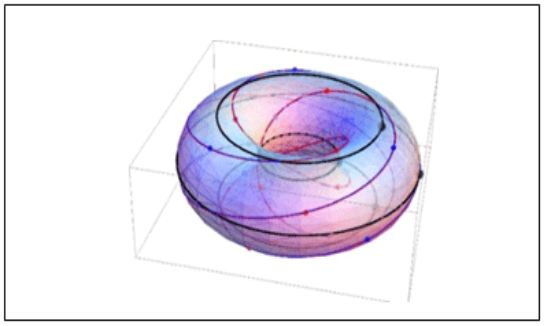

Figure 9: Triads, major, minor and augmented intervals positioned at rotoids, as composed motions of rotations, that circle a sub-unit of the torus, Amiot, E., 2013 .

Potential cyclic/spiral/toroidal and periodic character of particles in space-time

Elementary cycles theory (ECT) of Dolce [49], postulates that every elementary "particle" of nature is characterized by persistent intrinsic space-time periodicity. In ECT the Planck energy spectrum is interpreted as an harmonic like spectrum of a mass-less periodic modalities of fundamental time periodicity T (quantized energy: $E_n = nh\omega = nh/T$, discretized angular frequencies: nω, and time periodicity $T = h/E$)

According to't Hooft [44, 45], 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 would 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 [47, 48] as discussed by us in [9, 10].

Solitons/polarons, as quasi particles, are a widely observed physical phenomenon that behave like solitary waves, but possess many features of particles. They are able to suppress an harmonicity (the deviation of a system from being a harmonic oscillator) by the excitation of high quantum levels, a process that facilitates the crossing of potential barriers and the transfer of a molecule to a new conformational state [4, 11, 12]. Particle attributes and particle conformation in space are linked, and knots can be scheduled as solitons (polarons), while toroidal solitons can be depicted as braids and framing. When particles within fields, move around following classical laws, than these classical laws could resemble classical field theories such as the Navier Stokes equations and the existence of vortex and toroidal solutions [50, 58]

Also high-frequency quasi-periodic oscillations measured in a torus orbiting in the vicinity of a black hole probably obey to the Eigen frequencies of the proposed algorithm. According to Rezzolla [53], 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 Eigen frequencies found are in a sequence very close to 1:2:3:4. So cyclic energy trajectories and periodicity in quantum physics may be envisioned as recurrent spiral movements on a torus see Figure. 9.

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It is further proposed that Life Systems resemble typical coherent resonances of atomic cascade transitions of materials used to show Einstein-Podolsky-Rosen's argument, and Bell's theorem that should be placed by a local realistic process in space-time. Potentially, these informational frequencies are linked with the zero point energy field, through resonances leading to phase-locked cellular information attractors [36, 55], that are functionally separated by non-coherent wave activity [6]. 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 [50, 51, 55].

GM-scale and Superconductors, Applications in Quantum Computing and Health Technology

Finally the GM-algorithm was recently applied to the phenomenon of superconductivity, in the light of the current interest in Quantum Biology [18-23], a discipline that revealed that even at life temperatures; cells can operate in a coherent superconductor-like mode [13]. High Tc superconductors are composite materials made of multiple structural modules of units and their electronic structure has a multiple Fermi surface and multiple gaps in the superconducting phase. It is known that a fractal network of dopants can lead to a macroscopic quantum potential that facilitates macroscopic quantum coherence, see Turner [57]. By a meta-analysis of superconductor research with regard to coherence time promoting EM frequencies, it was clearly shown that these frequencies perfectly fit the GM-scale. This highlights the relevance of this biophysical principle for information processing in non-animate systems (see Table 1) and, interestingly, again provides a biophysical bridge between animate systems and non-animated materials. The knowledge of decoherence- preventing EM frequencies can potentially be used in superconducting materials that are currently elaborated for quantum computing. In this area, again the toroidal geometry seems to be relevant. It is of interest that decoupling of qbits from the environment may be realized through a toroidal pole setting, see Zagosking [58]. Only coherence sources inside the toroidal section of the qubit may limit the qubit decoherence time and this decoherence can be further reduced by applying multi-doped systems that obey to a coherent GM-scale. Toroidal multipoles are fundamental electromagnetic excitations different from those associated with the familiar charge and magnetic multipoles and have been held responsible for parity violation in nuclear and particle physics.

The Connecting Principle: Dual (Nested) Torus Operators Create Information Flux via a Wormhole Network

The collective data forwarded in our publications consistently present quite a diverse number of physical modalities that is also expressed in life systems: scale invariance/fractality, toroidal geometry, coherence/entanglement conditions as well as superconductivity, zero-point energy, elementary particles and a supposed pilot wave domain. Yet this spectrum of elements can be clearly connected through the assumption of an underlying *information matrix* [63-65]. The latter may be directly derived from the information flux in the nested torus with its central channel or, in more cosmological terms, its entangling wormhole structure [59]. We postulate an entangled torus/wormhole web, providing a fundamental connective principle that underlies the fabric of reality [6], that bears a electrometric signature exhibiting harmonic like features.

The particular torus/wormhole matrix, inferred from our work, is supported by the work of Susskind [69] and Haramein [59], who independently postulated that both space and time can be understood from the entangling properties of Einstein-Rosen bridges, in the so called ER= EPR framework (see for the time aspect also Moreva [66]). This scale invariant concept is not only based on macro-information systems such as linked black holes, but even on micro-events like elementary particle pairs that pop up in space and disappear again in the zero-point energy context. It has been suggested that the matter/antimatter parts of such pairs are connected through a wormhole-like structure [60]. The latter is pictured as a string in the 3D setting that is holographically conceived as a wormhole modality in a world of 4-spatial dimensions. Pair periodicity is often expressed as quantum fluctuations in the zero-point energy field. This occurs from the level of the electromagnetic Planck scale up to life cells, our planet, galactic systems and even the circular (rebound) character of the whole universe [65].

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 argued that, apart from the classical neuronal transmission system, an additional information guiding principle of quasi-particles such as polarons (solitons) is required to explain the super fast brain responses and the phenomenon of (self)-consciousness [6, 64]. The superconducting property of bio-photons in cell structures such as plasma-membranes, mitochondria, microtubuli, and coils of DNA, all associated with structured water layers [40, 42, 43], may be instrumental in the coherent synchronization of oscillatory neuronal networks in the brain, as suggested by us [6]. Super conducting properties have also been described recently in warm and wet conditions in the field of quantum biology, for instance in olfaction, magnetic navigation of animals and, in particular, in photosynthesis [19, 23].

It is of interest that toroidal wormholes may support electromagnetic and magnetic flux [62] and the same time can scatter electromagnetic waves [61]. Stable dual torus/wormhole structure and transparency require an energy field as well as a cavity with refractive indexes for efficient traversable conditions

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[62]. This latter aspect was also proposed for superluminal photon flux in neuronal micro-tubuli [67]. We speculate that the coherent set of discrete EM frequencies revealed by us is instrumental in creation of such super-radiance conditions. This, by superposing the particular frequencies on the manifest torus/wormhole density, explaining the congruent EM frequency patterns that, according to our studies, promote entanglement [9] and superconductivity [13], as well as energy distribution of elementary particles [10]. The latter were earlier described as toroidal knots [10].

Future research and applications

Living cells make use of coherent frequency signaling, similar to Bose Einstein condensates, in order to stay stable [15-17, 40-43]. If incoming man-made electromagnetic signals indeed exhibit de-coherent EM radiation, than these signals, potentially, will decrease the coherency of (quantum) wave domains of living cells. A possible way to deal with such a problem is either to lower the energy density of the external man made de-coherent waves and/or to convert them to more coherent frequencies. We envision innovative methods for increasing the coherency of the electromagnetic signals through the use of appropriate semiconductor and superconductor technologies. Coherent terahertz waves, obeying to the GM-function, could be produced by appropriate semi-conductive and superconducting materials, inserted in electromagnetic man-made devices. This by making use of the knowledge with regard to the earlier mentioned Terahertz gap, through enabling the combination of supplied optical and electronic coherent information. Beneficial EM wave technology may therefore find applications by further improving health during the increasing use of EM-information/data in our society as well as in the design of therapeutic instrumentation for various chronic diseases and ageing processes [5, 8, 13].

General conclusions

What can finally be concluded from the spectrum of data from our publication? 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. In order to understand their distribution pattern a semi-harmonic type of a mathematical relation is proposed. This relation is known from music theory, and called an adapted Pythagorean tuning [7, 46]. There are many examples of this kind of approach in physics, for example in defining a color spectrum with distinct frequencies, spin quantum states, Racah-coefficienten, Zeeman-states, LS-values, JJ-couplings, and quantum orbital moments among others. They all approach a distribution pattern of standing waves on the basis of whole numbers 1, 2, 3, 4 and (ir) rational numbers like 1/2, 3/2, 4/3, 5/2, 7/2, 9/2, $\sqrt{2}$, providing a semi-harmonic scale.

Any physical system that deals with quantized electromagnetic aspects and thus is based on standing waves and constructive wave interference can therefore be predicted to show such a discrete pattern of EM frequencies. In our papers on EM field-promoting effects on the degree of entanglement, and the EM field frequencies that may overcome superconductor gaps as well as the mass/energy derived frequencies for the known elementary particles, demonstrated, albeit retrospectively realized, the predicted fit with a coherent GM-scale. The most striking element, however, is our primary observation, that life systems as studied in the 500 biomedical reports show this distinct EM frequency pattern. This strongly suggests that coherence, entanglement and superconductivity may be prerequisites for life. In fact, superconductor features have been demonstrated in current quantum biology: in olfaction, long distance magnetic navigation of various animal species and in particular in photosynthesis [19, 23]. It should be realized also 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 [12, 13 and 40-43]. The latter aspect was suggested by us also be instrumental on the process of 3D- folding of proteins to their functional structure, as supported by many other studies reviewed in [14-17, 40-43].

Also the major influence of coherent (preventive) and non-coherent (pathology inducing) EM fields on cancer and neurological disorders highlight the current interest in biofield research and health technology. The various interrelated aspects of our studies are depicted in Fig.10, in a circular mode, going from the initial life algorithm study to the proposed semi-harmonic scale, the earlier mentioned Chladny patterns [1, 2] and subsequently the follow-up studies on entanglement, superconductors and elementary particles, to be finalized in the creation of photon energies, phononic lattice vibrations, the involvement of quasi particles and finally closing the circle with the study on protein folding and EM field effects on tumor growth and neurological disorders.

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 in many other related studies. We consider the torus as a versatile space-time operator for the handling and integration of information 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 [61]. Such field-sensitive toroidal

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workspaces have been postulated as a key element for the creation of scale invariant consciousness in the universe [6]. It remains to be shown whether an implicate order, as proposed by Bohm, finds it physical expression in an information/geometric domain described either as a liquid crystal matrix, zero-point energy fluctuations or quantum foam at the level of the Planck scale or even beyond this domain (see Figure 10). The reviewed studies may contribute to a better understanding of the bio-fields that operated in the evolutionary organization of complexity, on the brink of inanimate and animate structures, and still are instrumental in the ongoing fabric of human and cosmic consciousness.

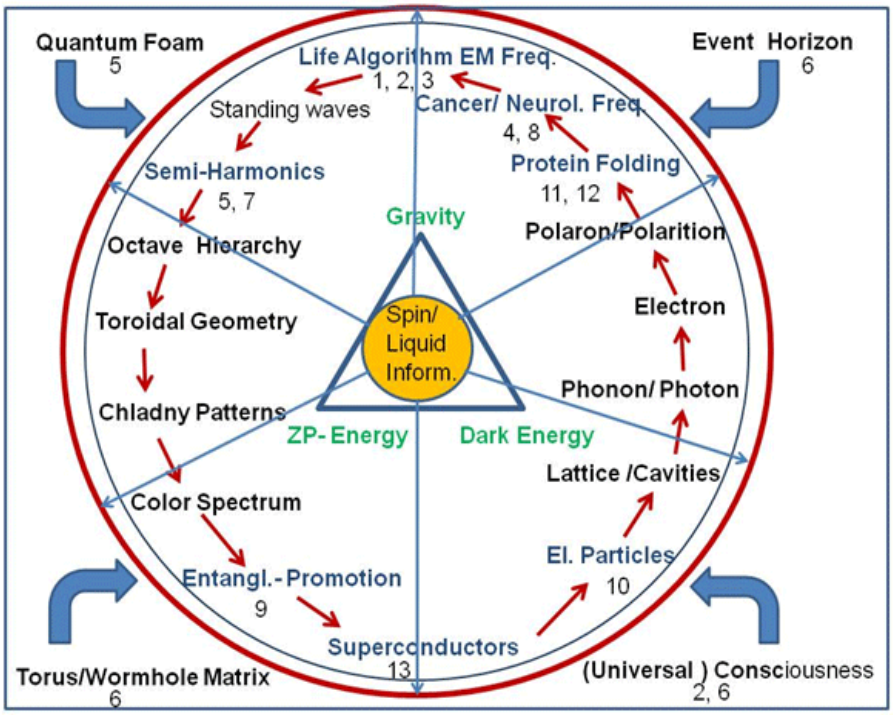

Figure 10: The cycle of interrelated biophysical and physical observations of the 13 reviewed papers of the present authors (depicted in black in the figure as ref. number in list 1), with the various aspects dealt with.

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