Quantum Wave Information of Life Revealed: An Algorithm for Electromagnetic Frequencies that Create Stability of Biological Order, with Implications for Brain Function and Consciousness

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ABSTRACT

We propose a hypothesis of a mathematical algorithm for coherent quantum frequencies, that may create stability of biological order. The concept is based on an extensive literature survey, comprising 175 articles from 1950 to 2015, dealing with effects of electromagnetic radiation on *in vitro* and *in vivo* life systems, indicating that typical discrete coherent frequencies of electromagnetic waves are able to stabilize cells, whereas others cause a clear destabilization. We find support for the hypothesis of H. Fröhlich, that a driven set of oscillators condenses in a broad energy range, may activate a vibrational mode in life organisms at room temperature. Taking into account the life sustaining frequencies, as extracted from literature, an algorithm of coherent frequencies of standing waves for the stability of biological order was inferred. Interestingly, we found that the origin of the particular biological algorithm can be mathematically approached by a selected "tempered Pythagorean" reference acoustic scale. The algorithm expresses one-dimensional wave equations known for vibrating strings. The origin of the biological algorithm was condensed in a mathematical expression, in which all frequencies have ratios of 1:2 and closely approach ratios of 2:3. This inferred algorithm was subsequently verified with regard to various frequencies of electromagnetic waves, as applied in the above-mentioned independent biological studies. It was also matched with a range of 23 different measured quantum resonances emitted by a selected inorganic silicate mineral, that is able to catalyze the oligomerization of RNA. The selected silicate was experimentally shown to act as a quantum replicator, specifically emitting EM radiation at frequencies that are fully in line with this algorithm. Such silicate quantum replicators, therefore may have been instrumental in the initiation of first replicating, life, cells at the edge of pre-biotic evolution. Our model may imply that, at the quantum scale, an underlying electromagnetically defined order may have been present, that was a prerequisite for the coding of synthesis and functional arrangement of cellular elements in biological evolution. Far infrared dynamics, reminiscent of coherent non-relativistic super fluids in 3+1-dimensions, may have played a role. Finally, we address the question whether the identified electromagnetic fields may also influence neural systems in general and human (self) consciousness in particular. We are finding support for recent electromagnetic and stochastic zero-point energy field theories in quantum consciousness studies. The striking similarity of electromagnetic wave frequencies, detected by us in the biological studies, and in selected clay minerals, as well as in color spectra, tone scales and sound induced geometric Chladni patterns, may indicate that we identified the involvement of a universal electromagnetic principle, that underlies the observed life sustaining effects and also may have been instrumental in the creation of biological order in first life and quantum consciousness.

Key Words: life algorithm, eigenfrequencies, coherence, biological systems, Bose-Einstein condensates, Fröhlich, silicate minerals, quantum replicators, EM frequencies, quantum biology, quantum field, consciousness

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1. Introduction

It has become clear in the last decades that living organisms on earth are exposed to various long distance fields such as gravity/inertia as well as to zero-point energy/dark energy fields, and in addition are exposed to a whole spectrum of electromagnetic radiation modalities, related to the physical constitution of earth and our planetary position in the solar and galaxy systems. Many studies indicate that quantum mechanical information may have had an essential role in the evolutionary creation of first life and the buildup of consciousness in nature, in particular as to the multitude of life forms that inhabit earth (Davies, 2004, Kaufmann, 2015).

In humans, the extremely complex neural system for disposition of sensory and extra-sensory information is based on electro-chemical and neurohormonal signaling processes and concepts for quantum mechanical and electromagnetic operation of brain processes have earlier been proposed (Mc Fadden, 2007, Pockett, 2012). The integral subject of quantum consciousness has been reviewed by Atmanspacher, 2008; Vannini and DiCorpo, 2008; Meijer and Raggett, 2014; Tarlaci, 2015, among others.

Einstein, 90 years ago, pointed out that bosons could condense in unlimited numbers into a single ground state since they are governed by Bose-Einstein statistics and are not constrained by the Pauli exclusion principle (Einstein, 1925). Fröhlich claimed oscillating charges in a thermal bath, in which a large numbers of quanta may condense into a single state known as a Bose condensate, which could constitute a physical and non-thermal interaction between cells (Fröhlich, 1968).

Open boson systems have been proposed by Luzzi and Vasconcellos, if sufficiently away from equilibrium, may have relevance in the functioning of information-processing biological and condensed matter systems. The so-called Fröhlich–Bose–Einstein condensation is a self-organizing-synergetic dissipative structure, a phenomenon working in biological processes and present in several cases of systems of boson-like quasi-particles in condensed inorganic matter (Vasconcellos and Luzzi, 2012).

Wave-particle duality in quantum physics was proposed from around 1920 and still seems a crucial concept. Yet, Einstein was not happy with a quantum jargon mixing wave and particle elements and was sure that wave-particle duality should be finally resolved in favor of a wave model perse. Indeed nowadays quantum biological effects at room temperature have been discovered (reviewed by Arndt *et al.,* 2009; Ball, 2011; Lambert *et al.,* 2013; Lloyd, 2014; Huelga and Plenio, 2013).

Schrödinger's wave equation describes the statistical nature of eigenstates that exhibit wave-particle duality. The wave function gives the potential energy of waves and is associated with respective wave numbers related to wavelengths or energy levels known as a quanta. In his book *'What is Life'* Schrödinger promotes the idea of the presence of a molecular code-script, which supplies external information to realize biological order in life cells. In this code script, coherent states of a classical harmonic oscillator might be involved in order to obtain a quantum description (Schrödinger, 1944).

Referring to quantum theory, Bohm evolved a theory of the universe, called the "Implicate Order" (Bohm, 1980). This theory resembles the concept of Richard Feynman, assuming that in quantum electrodynamics charged 'particles' somehow generate spherical electromagnetic 'in and out waves' within a quantum field. A relation between 'living' and non-living matter has also been made by Wolfgang Pauli. He stated that the mental and the material domain are governed by common ordering principles, and can be understood as "complementary aspects of the same reality" (Pauli, 1994).

While the ecosystem is a system governed by neg-entropy, a driven set of oscillators might condense with nearly all of the supplied energy, specially activating the vibrational mode of the lowest frequencies at room temperature (Del Giudice, 1989). In this manner biopolymers make use of a quantum system of many bosons, according to Bose-Einstein statistics, being embedded in a surrounding field (Fröhlich, 1968; 1988). A possible way to describe quantum resonance is by wave interaction: there is not an irreducible randomness, and a driven set of preferred oscillators at certain frequencies plays a role to increase the degree of its coherence. Coherency of resonances has been studied, among others, for microtubules (Sahu *et al.,* 2013 and b). A wave equation describing a Fröhlich system for cellular physiology has been proposed, which describes the coherence between individual

oscillations using a number of energy quanta concentrated in one vibrational mode above the thermal equilibrium level and using an ensemble of interactions counting two or three coupled oscillators (Pokorny, 1998; Šrobár, 2012). A model to predict electromagnetic resonances in proteins, RNA and DNA has been proposed, based on findings that energetic periodicities of delocalised electrons along a molecule are critical for the function of proteins, DNA and RNA (Cosic, 2015).

Coherence and interaction of waves is coupled to entanglement and it was Schrödinger who recognized entanglement as 'the characteristic aspect of quantum mechanics and suggested that eigenstates or preferred states are able to survive interaction with the environment (see also Ogryzko, 2008). Using the Laplace operator, the Maxwell wave equation can be taken in two parts: in a vectorial part, which results from this equation and in a scalar part, according to which the divergence of a field pointer is a scalar. If the field vector is derived from a scalar potential, then this approach leads to a wave equation, which is defined as a plasma wave. Solutions are known for electron plasma waves, which are longitudinal oscillations of electron density (Meyl, 2002).

Interestingly, Pythagoras, a Greek philosopher and mathematician, has studied the mathematics of coherency of waves in the late 6th century BC, which is known as 'Pythagorean-tuning'. This aspect can be found for example in a musical tone scale, based on audible frequencies of a string, in which frequency ratios of intervals have been based on ratios of 1:2 and 2:3 and approximations thereof. The order and coherency of musical scales has been discussed by many physicists (Barbour, 1951). E. Chladni has already shown in 1787, that coherent patterns of geometric shapes are formed in suspended materials on vibrating thin square plates, exposed to typical pitch frequencies, also called *eigenfrequencies*.

We raised the question whether it would be possible to find direct evidence for this information-processing system in the room temperature range by: 1) analyzing preferred wave frequencies able to stabilize and modify living cells, 2) analyzing preferred wave frequencies in condensed inorganic matter and 3) to find a direct relation between coherent quantum resonances and preferred electromagnetic wave frequencies.

Three considerations were our starting point for the search to preferred frequencies of coherent waves for living organisms and condensed matter: 1) a supposed quantum wave model, 2) the, abovementioned, idea of Einstein that quantum randomness is not the only determinant of the fabric of reality 3) the conclusion of Schrödinger that living cells need *external* quantum information for their development and ecological survival. To understand why electromagnetic waves and quantum states with typical frequencies have a positive or negative influence on cellular function, the current knowledge of physics/biology interactions on life organisms is highlighted in the present paper. A wide variety of studies is available about the use of electromagnetic waves to improve the viability and proper repair of cells, or to prevent the metastasis of cancerous cells. (see appendix 1). Yet, electromagnetic radiation also can have detrimental effects both *in vitro* and *in vivo*.

We found also that much relevant knowledge is available at present, about electrochemical features and nano-chemical properties of nano-materials, including their influence on biological systems and living cells. A unique form of wave coherence is supposed to be present at multiple scales in biology and a better characterization of this may have broad consequences for the understanding of living organisms as complex systems (Robert, 2012).

The following material is presented in four subsequent sections:

- The hypothesis of a mathematical algorithm for coherent quantum frequencies to create stability of biological order.
- Our meta-analysis of literature concerning the effects of non-thermal radiation on life systems, with the aim to identify preferred coherent frequencies of waves that apparently affect life and, on the basis of these results, attempt to define an underlying biological algorithm.
- To position these results in a wider perspective, namely in relation to the quantum vibration world we live in, with special reference to the electromagnetic absorbing and radiation modalities of complex clay minerals that may

constitute potential life-protective quantum wave replicators

o To discuss these crucial electromagnetic transmutation and signaling properties of silicates in relation to the quantum conditions that may have been instrumental in the creation of first life, as well as the potential influences on quantum neural resonance and coherence.

2. Hypothesis of a mathematical algorithm for coherent quantum frequencies to create stability of biological order and its verification

In theoretical physics, quantum field theory (QFT) is a theoretical framework for constructing quantum mechanical models of subatomic particles in particle physics as well as for quasi-particles in condensed matter physics. Quantum field theory explicitly recognizes an extended vacuum field interacting with matter, as well as intrinsic quantum fluctuations. The entire universe can be seen as consisting of fields, reflecting a spectrum of particles such as electrons, photons, quarks, gluons, muons and Higgs bosons, of which the vibrations thereof are constantly interacting with each other. It is proposed that these fields consist of harmonious and coherent waves that can be described as quantized string oscillators. Inherent characteristics of a quantum field involve: 1) the presence of standing waves, 2) charged subatomic 'particles' in a plasma, 3) elementary particles represent field phenomena, 4) charged 'particles' generate spherical 'in and out waves' and 5) not only 3-D but even 4-D structures of waves are at stake. We decided to use an analogue from the science of musical scales, to describe such harmonious and coherent standing waves. This provides necessary preconditions to arrive at regular 3-D geometries, and also enable an entrance to 4-D geometries. The demands of tuning standing waves in order to attain a perfect coherent scale and associated temperament have already challenged many scientists from the earliest civilizations onward. Barbour surveyed these longstanding problems, and offered an account of the history of tuning and temperament (Barbour, 1951).

As mentioned above, the Pythagoreans worshipped whole numbers and held a belief that whole numbers can be used to explain 'everything' in the natural world. The most harmonious interval is commonly thought to be an octave (1:2) combined with a fifth (2:3), which is generally agreed to represent the second most harmonious interval, that is, within a tone scale of twelve basic frequencies. Standing wave patterns can be produced in a medium, if two waves of identical frequencies interfere in such a manner that they produce stable points along the medium. These points that have the appearance of standing still, are referred to as nodes and the variety of actual wave modalities can be produced by distinct patterns characterized by a collection of different nodes. Such standing wave patterns can only be produced at certain frequencies and each separate frequency is associated with a different standing wave pattern. The frequencies and their associated wave patterns are referred to as harmonics (see Figure 1).

For a fixed string there is also a direct relation between the harmonics and the overtones. The harmonic of a wave is the component frequency of the signal. This is an integer multiple of the fundamental frequency, i.e. if the fundamental frequency is f, the harmonics have frequencies 2f, 3f, 4f, 5f, . . etc. (Figure 1). The harmonics have the property that they are all periodic at the fundamental frequency, and therefore the sum of harmonics is also periodic at that frequency.

An algorithm of multiple scales is proposed based upon a tempered Pythagorean scale and composed only by connecting approximated stacks of fifth's (frequency ratio of 2:3), and octaves (ratio of 1:2), while 12 discrete frequencies fit within each octave. By making use of scales of fifths and octaves there is an algorithmic relation between the basic frequencies, the overtones and harmonic frequencies. Reasoned from one scale: 2 frequencies are ordered 1:2, 6 frequencies are powers of 2 and 3, 5 intervals are 2:3, 6 intervals approach 2:3 with a difference of less than 0.1%, and one interval approaches 2:3 with a difference of less than 1.34% causing circular polarized traveling waves. If a frequency of one cycle per second is used, which is 1 Hertz, than all frequencies in all scales can be calculated. Under these conditions preferred coherent frequencies also called scalars of a so called 'reference scale' can be calculated: 256.0, 269.9, 288.0, 303.1, 324.0, 341.15, 364.7, 384.0, 404.5, 432.0, 455.1, 486.0 Hz.

This particular scale is called a 'tempered Pythagorean scale and it's patterns of harmonic and coherent waves can be extended to all frequency scales: all lower and higher preferred

frequencies are entangled by this scale and can be simply calculated by multiplying or dividing each preferred frequency of this reference scale by powers of 2. In this manner about 127 scales having coherent algorithm frequencies can be derived from 0.001-Hertz till the highest possible frequency of ≈6.2x10^34 Hz. The latter is related to the smallest theorized unit of distance of the Planck length, as represented in a mathematical algorithm of coherent frequencies. Examples of preferred frequencies according to the 'mathematical' algorithm have been given in appendix 2. Mathematically, coherency can be described by multiple one-dimensional wave equations for vibrating strings with algorithmic intervals (Figure 1 and D'Alembert, 1747).

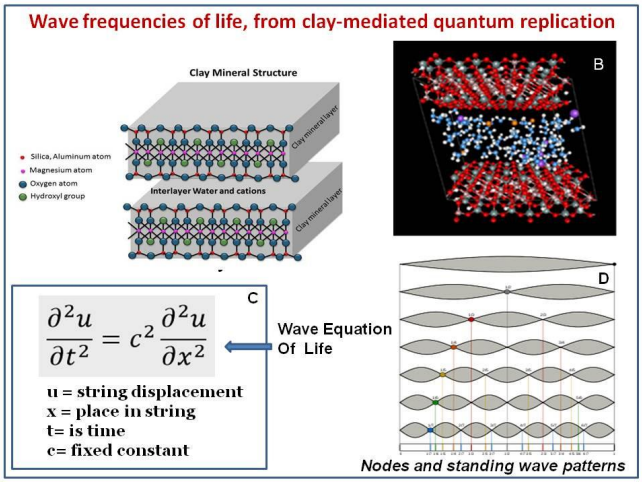

Figure 1. Molecular structure of a clay mineral (A and B) and wave function describing the ordering principle in life processes as an algorithmic standing wave system (D) that can be derived from the wave equation depicted in the inset (C).

It is proposed by us that, in principle, the nature of these preferred frequencies of electromagnetic waves can also be found in the frequencies of quantum states of atoms and molecules. Therefore, these frequencies, might be able to stabilize Bose-Einstein condensates at room temperature. It is further hypothesized that nature makes use of these frequencies to create stabilization of biological order within a natural quantum field, as once discussed by Schrödinger. Next to this it is proposed that nature makes use of quantum replicators such as clay minerals able to emit these preferred quantum frequency waves, and thereby also may have played a role in the creation of first life.

The mutual coherence of resonances and interference of quantum states of ions, molecular groups may explain many of the current paradoxes surrounding the non-thermal action of electromagnetic fields on living cells. Abundant sources of litereature were available, in which effects of 'non thermal non ionizing radiation' on the viability of cells have been described. Typical biological effects of 'non-thermal' natural as well of man made electromagnetic waves on living organisms are well known:

1) Influences of natural Schumann electromagnetic waves on the well-being of human individuals and other living organisms has been found (König, 1960).

2) 'Non-thermal' millimeter waves affect cells in coherent multi-quantum oscillations only at specific frequencies, being separated by wide ranges of non-effective frequencies (Devyatkov, 1974, Fröhlich, 1988, Betskii, 2000).

3) Harmonics and subharmonics of biologically important ions are involved in frequency-dependent effects in different cells at extreme low frequencies (Blackman, 1979).

4) Natural microwave resonances present in the upper atmosphere have a positive or negative influence on well-being of living organisms on earth (Avakyan, 2006).

5) Biological effects of non-thermal man-made electromagnetic waves on cells take place (Cifra, 2011).

6) Symptoms such as fatigue, stress, irritation, frequent headaches and sleep disturbances due to the presence of electronic devices and electric cables have been found (Zwamborn, 2003; Adang, 2006; Nittby, 2007; Johansson, 2010; Havas, 2013).

7) 'Non-thermal' electromagnetic fields can have effects on stem cell gene expression (Muehsam, 2014).

8) There is a functional role of rhythmic neuronal synchronization, which is called a 'communication through coherence' (Bastos, 2014).

9) Tubulin and microtubules have specific resonance frequencies in the range from kHz to THz (Sahu and Bandyopadhyay, 2014).

10) Biological functions of "serial" signaling pathways of proteins can be described by spectral patterns of peak frequencies from a field perspective (Persinger, 2015).

To verify the proposed underlying algorithm, we studied the reports of biological

studies from 1950 to 2015, dealing with effects of electromagnetic radiation on *in-vitro* and *in-vivo* life systems, in which typical discrete frequencies of electromagnetic waves, were chosen by the particular authors. Collectively, 175 independent biological studies were identified, describing the influence of single preferred wave frequencies on cells. In total 97 different frequencies of electromagnetic waves were applied in these studies, that were found to support the quality of cells, whereas 5 typical frequencies were reported that negatively influenced cells (see appendices 1 and 3). All of the applied frequencies are in the frequency band from extremely low frequencies: one tenth of a Hz to high frequencies: PHz, and replication studies of the applied frequencies have generally been made.

The experiments in these studies were in the areas of: neuro-stimulation, brain stimulation, spinal cord stimulation, self-assembly via tunneling current of microtubulins, transcranial magnetic stimulation, reduction of Parkinson, anti-proliferative effects on tumor cells, inhibition of tumor growth, improvement of memory, rhythmic neuronal synchronization, improvement of attention, wound healing, decrease of inflammatory cells, increase of bone growth, reduction of diabetic peripheral neuropathy, increase of fibroblast proliferation, stimulation of angiogenesis, granulation of tissue formation and synthesis of collagen, promotion of proliferation of human mesenchymal stem cells, entorhinal-hippocampal interactions, among others.

The different, beneficial, frequencies identified by us in this total data base as derived from these studies, were established to be manifest in a broad range of ELF, kHz, MHz, GHz, THz and color-frequencies. Listing the various EM (electromagnetic) frequencies used, pattern recognition shows that all of the registered biological frequencies can be positioned at or close to all scalar frequencies described by the mathematical algorithm with a strikingly narrow band width.

This implied that the particular 97 different radiation data from the 175 studies, representing about 190 different frequencies, represent also a biological algorithm and provide a first clue for an underlying mathematical algorithm. Based upon these findings and the proposed algorithm, all of the applied biological frequencies, representing 97 local maxima, can also be normalized to a mathematical 'reference-scale' with 12 local maxima, by dividing or multiplying the reported applied frequencies by powers of 2. It could be concluded that the normalized biological frequencies show a distinct pattern at and around these 12 scalar reference frequencies of local intensity maxima (Figure 2). A measure of exactness, compatible with the conditions of the algorithm frequencies, is the mean absolute difference in between the applied and calculated frequencies, and represents a band width around the 12 preferred frequencies. This band width, calculated for the investigated biological experiments, is very small and amounted to: 0.78%. The highest possible theoretical coherency can be met when the mean bandwidth is 0%, a high coherency is assumed at around 0.78% and no coherency exists when the mean bandwidth is >1.50%.

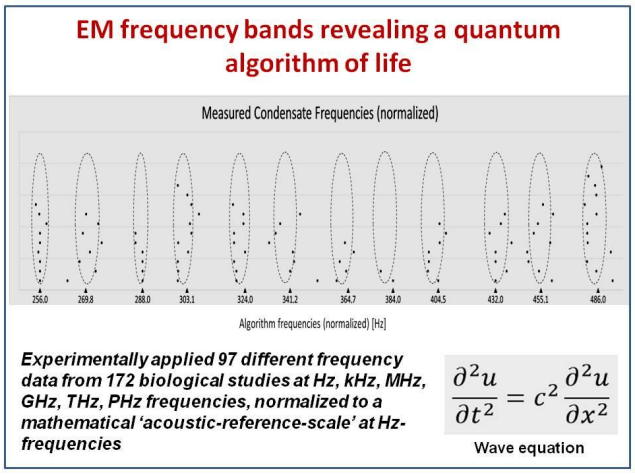

Figure 2. 12 algorithmically based, scalar, frequencies, at which biological experiments with 97 different frequencies could be positioned. The EM frequencies were experimentally applied to various in vitro and in vivo life systems, resulting in beneficial effects. All data at frequencies of Hz, kHz, MHz, GHz, THz could be normalized in an logarithmic acoustic reference scale (Hz). 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.

We conclude that all selected biological frequencies from the independent studies, over a wide spectrum of frequencies of EM waves, fit with the calculated pattern of the proposed mathematical algorithm of frequencies, and show a high coherency in a frequency window of one tenth of a Hertz till PHz.

Detrimental effects

Interestingly, a total of 11 articles were identified that showed negative biological effects of EM

waves, in particular when living cells were exposed to frequencies just in between the above mentioned coherent frequencies of the algorithm. These biological studies were performed in the very different areas of mutagenic response, phototoxic effects on the human eye, alterations in immune reactivity, decrease in sperm viability parameters, increased anxiety-related behavior, reduced mobility, and neurological depression. The particular non-favorable values were invariably located at frequencies, exactly in between those that were favorable for life processes, within a small bandwidth. Studies on radiation exposures of eyes, for example, showed that frequencies of blue light around 435 nm are clearly phototoxic for the human eye health, especially with regard to detrimental effects on the retina (Smick, 2013; Tomany, 2008). The wave frequency of 435 nm is just in between two calculated coherent colors of the algorithm at 420.8 and 449.4 nm (appendix 2), and showed a distance of 0.02% from the calculated (not preferred) frequency. This value was further designated by us as a non-coherent color blue.

Photosynthesis

The evidence for essential quantum effects during photosynthesis has already been shown (Engel, 2007; Whaley, 2011, Butkus, 2015). The reason that efficiency of this process is so high in living plants, is that the entire process of transmitting solar energy inside the leafs takes place under the conditions in which the energy remains in a quantum state. Quantum coherence in electron transfer in photosynthesis lasts for a long time (600 fs) in the pigment–protein complex (Engel, 2007; Ishizaki, 2010). But it is not yet fully known how this coherence is brought about in living tissue, although it has been shown that environmental noise increases energy delivery efficiency (Panitchayangkoona, 2010; Collini, 2010). The inferred algorithm of the present study shows that this coherence may be embedded in both higher and lower frequency bands. Plants are using mostly chlorophyll *a* and chlorophyll *b* in the process of photosynthesis. Of note, the color frequencies of chlorophyll show distinct maximum absorption peaks in blue and in red regions of the visible spectrum near chlorophyll: 450 nm and chlorophyll: 675-680 nm. Both color wave lengths are close to the proposed preferred frequencies described by the algorithm at a mean bandwidth of 0.59%, which means that both color frequencies are highly coherent. Pigment spectra of algae are also close to the proposed preferred coherent frequencies: 340 nm, 740-750 nm, phycoerythrin: 560 nm, phycocyanin: 605-610, phycocyanin: 630 nm: chl0rophyll: 420-450-675 nm, (Myers, 1999; Griffiths, 2011, Astoreca, 2005), and show a mean average bandwidth of 0.44%.

Color spectra

How our brain separates the properties of light, energy and wavelength, and then recombines them into color perception is still unknown (Wright, 1946), but color should be explained at the level of single cells in our brain (Gouras, 2007). Color scales have been studied by Newton in 1704 and by H. von Helmholtz in 1867. Helmholtz proposed an analogy between colors and sound, and has published this concept (Helmholtz, 1863; 1867). He did not attempt to provide a quantitative determination of the wavelengths of the proposed analogy. The color scale proposed by Helmholtz approaches the color scale based upon the algorithm, that is if 432 Hz is used in the concept of Helmholtz instead of a pitch of 440 Hz.

Musical tone scale

A musical tone scale can now be calculated making use of the algorithmic frequencies. The tones in this scale has a frequency ratio of 1:2 and approaches the ratio 2:3, and 6 frequencies of the tone scale obey to powers of 2 and 3, which means that the tone A is tuned at 432 Hz and C at 256 Hz, which is the same tone as proposed by mathematician John Herschel in the mid-19th century. A similar scale has been proposed by the Schiller Institute in 1939, but a pitch of A at 440 was accepted internationally and standardized by the International Organization for Standardization in 1955, in order to serve as the audio frequency reference. James Furia and many others have later asked to use A at 432 or C at 256 be the standard, which was often used by classical composers and resulted in a tuning of approaching whole number frequencies (Furia, 2012).

Sound induced geometric shapes

Researchers have further validated the connections of sound and mechanical vibrations on the basis of geometric shapes: at typical pitch frequencies geometric patterns will be formed.

The German scientist Ernst Chladni was the first in 1787, who made a clear connection between sound waves and the generation of visible coherent standing waves in a membrane. Later, Nathaniel Bowditch, 1815 concluded that these structures arise because the frequencies are approaching whole number ratios to each other: 1:2, 2:3, 3:4. Eigen-frequencies of Chladni patterns have been analyzed by us for thin square and round plates at 96, 142.2, 190, 340, 490, 800, 1033, 1225, 2041, 3240, 4129, 4671, 5201, 5907, 7800 Hz. It turns out that this sequence is very close to the proposed algorithmic frequencies in the present paper, and shows the same coherency of scalars.

3. The role of nano- and submicron minerals as quantum replicators

Aristotle observed unity in living and in lifeless objects and developed the idea of matter and form. Life was supposed to be supported by a principle of life: the form (Greek morphe, Latin forma), that "informs" a specific type of matter (Greek *hyle*, Latin *materia*), such that it becomes a living organism. More recently, Davies, considered the existence of quantum replicators, related to a potential quantum algorithm. He argued that quantum mechanics may play a nontrivial role in various life processes, particularly in the physics determining the speed of polymerases (Davies, 2004). The need to involve quantum mechanics to understand the origin of living cells is firstly due to the fact that quantum processes allow a large amount of a priori information to be stored, and second, that quantum processes may better explain the accuracy by which the 3-dimensional molecular machines are constituted and work (Melkikh, 2004). A system with a large number of entangled qubits in a pure state might (in principle) maintain itself (Matsuno, 2012).

Nano- and micron mineral particles, present in nature, can exhibit preferred coherent condensate frequencies and thereby may act as energetic oscillators, able to supply externally quantum information to living cells. Silicate minerals, for example, can have a high coherency of frequencies and may act as a template for preferred discrete oscillations. These minerals have been regarded as candidates for trans-material catalysts, since they are resonance carriers that are able to resonate within a quantum field (Bechmann, 2013). Therefore, a causal association between preferred coherent frequencies of minerals and biological frequencies might exist.

It has been found that 'Eigenstates' of metamaterials, based upon nano and submicron silicate minerals, can have coherent frequency patterns located in bands of UV, colors, IR, FIR, MHz, ELF and approach mutual frequencies ratios of 1:2 and 2:3 (Geesink, 2014). The same minerals are candidates to catalyze the formation of RNA-like molecules (Pitkänen, 2015) and have typical eigenstates. 'Eigenstates', in quantum mechanics, are states with a characteristic wave function, independent of time, corresponding to typical quantum states and eigenfrequencies. The investigated silicates show boson-like quasi-particles resonances, which have been measured by Geesink, 2014, by low frequency Raman, FIR spectroscopy, Fourier transform infrared spectroscopy, photoluminescence as well as UV Spectroscopy, X-ray spectroscopy (the latter to detect inherent radioactivity) and were shown to be located within scales of X-ray, UV, light, IR, FIR. Of note, extreme low frequencies (ELF) may also play a role, but one did not yet succeed to measure these frequencies. A potential relation between these ELF frequencies and ion-cyclotron resonances might exist.

Meta-materials, such as clay minerals, are condensed materials, engineered in assemblies of multiple individual elements that are arranged in periodic patterns and gain their specific properties from their composition and designated structures, such as their precise 3-D shape, micro-geometry, overall size, molecular orientation and arrangement, features that also determine their generated electromagnetic waves and quantum transitions. Meta-materials show a relation with "geometry-fractality-quantum dynamics" and therefore unison and harmonic oscillations may occur. Typical meta-materials are clay minerals, that have also been studied by scientists, who try to unravel the origin of life. Coyne (1985) has discussed a possible energetic role of quantum states of silicate surfaces in the evolution of life (Figure 3).

The electronic structures of the minerals have been considered in terms of band theory and localized defect centers and provides a predictive theoretical framework from which to rationalize the capacity of these materials to store and transduce energy.

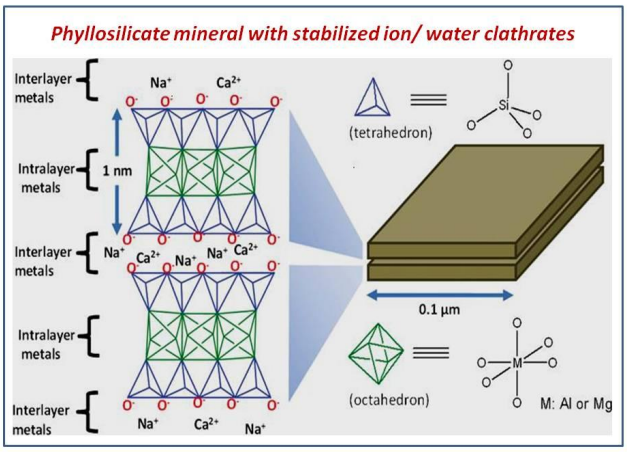

Figure 3. Phyllosilicate mineral with stabilized ion/water clathrates. The metal ion-doped silicate structure exhibits platonic geometries (After G. Sposito).

The bulk crystal is seen as a collecting antenna for optical, infrared and electronic energy, of which the defect centers serve as storage sites. The mobility of charge and electronic excitation between the defect centers may constitute a primordial inorganic electron transport chain (Coyne, 1985). J. Ferris studied the same types of minerals, formed by the weathering of volcanic ash, and found that these minerals may have played a central role in the origin of life. The structure of this clay mineral allows the adsorption of organic compounds and, among others, this contributes to the ability to catalyze the formation of RNA molecules (Ferris, 2005). Szostak found that the same clay minerals aid in the creation of vesicles that are needed to create a primitive cell (Szostak, 2005). Phyllosilicates (see Figure 3) have also been proposed as binary automata and as non-rectangular lattice analogs of "Conway's Game of Life" cellular automata: in the clay each node updates its state in a discrete time, depending on a sum of states of its three (silicon) and six (oxygen) neighbors (Adamatzky, 2013). In this framework, the origin of chirality of bio-molecules has been related to so called Rydberg matter, which are highly excited clusters of atoms with one valence electron of a principal quantum number n >>1, that generate circularly polarized light and are present in the higher atmosphere (Holmlid, 2012).

Silicate minerals, within the class of a potential catalyst for RNA, are able to emit assemblies of electromagnetic waves at typical frequencies, caused by the different quantum states, when activated by energy (see section 4). The discrete frequencies of these quantum states are in the spectra of ELF, FIR, IR, light, UV and X-ray (radioactive elements), and are located at the scalars described by our algorithm.

The measure of coherency of these silicate frequencies can be calculated by taking the mean absolute difference between the measured frequencies and the calculated preferred frequencies according to this mathematical algorithm.

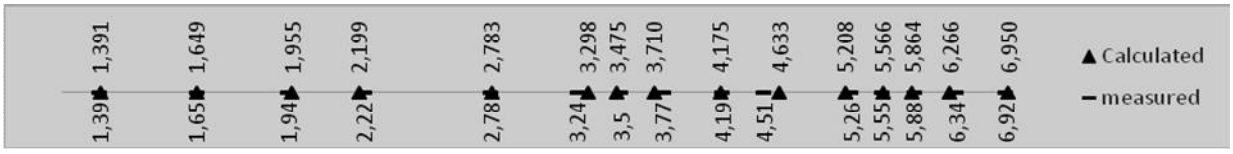

Figure 4. Measured and algorithmically calculated EM THz frequencies for a silicate mineral at a logarithmic scale.

The calculated absolute bandwidth amounts to 0.75% for 23 different measured frequencies, which means that the coherency of the resonant frequencies of the silicate is high and occurs at the same level as the coherency for the selected 97 different beneficial biological frequencies identified by us in the total established data base of derived biological studies. This was shown to be manifest in a broad range of ELF, kHz, MHz, GHz, THz and PHz. An example of the preferred frequencies of this silicate mineral in the THz-range is given in Figures 4 and 5.

4. Electromagnetic signaling properties of clay under quantum conditions that may have been instrumental in the creation of first life

Clays as assemblies of silicate minerals are proper candidates for key elements in prebiotic evolution, since they can replicate and can form a dynamic basis for the assembly of poly-alpha-aminoacids and poly-nucleotides in the process of the polymerization to oligomers (Ferris, 1996; Guggenheim, 1995; Hashizume, 2012). Yet polymerization alone is not sufficient: also a distinct functional sequence of the particular

building blocks is required. In this respect it is essential that clay-minerals, as mentioned above, also display electromagnetic properties (Adamatzky, 2012), both by resonating with non-local force fields such as zero-point energy wave activity, and in general can act as quantum wave replicators. We propose that the resulting wave patterns may induce an ordering influence on EM radiation sensitive life systems, with major implications for sequence coding in the formation of bio-molecules and/or protective (repair)effects aimed at preservation of functional molecular structures as well as coherence of metabolic networks.

FIR (THz) frequencies of a quantum replicator

Measured	Calculated	Difference in %	Measured	Calculated	Difference in %
1.39	1.391	- 0.07%	3.77	3.710	+1.59%
1.65	1.649	+ 0.06%	4.19	4.175	+0.48%
1.94	1.955	-0.77%	4.51	4.633	+1.63%
2.22	2.199	+0.95%	5.26	5.208	+0.99%
2.78	2.783	-0.11%	5.55	5.566	-0.29%
3.24	3.298	+1.79%	5.88	5.863	+ 0.27%
3.50	3.475	+0.714%	6.34	6.266	+1.17%

Figure 5. Frequencies of a clay quantum replicator at discrete FIR-frequencies (recorded with JASCO FTIR-620 spectrometer equipped with Hg-lamp power supply and beam-splitter) and differences in between measured and calculated values.

Silicates have the presence of OH- groups, multivalent ions and water clathrates within the compacted nano and submicron galleries of silicium-oxide layers, which inherently have obtained a coherent vibrational character. It follows that this antenna structure is open for absorption and emission of quantum wave information. They can receive, as well as produce, coherent EM radiation patterns and, in this manner, in fact function as quantum wave replicators, (see Figure 5: depicting measured FIR-resonances versus calculated resonances according to the algorithm, and differences between measured and calculated values). The ZPE (zero-point energy) coded information might be collected and transferred to prebiotic (proto-cell) structures, offering coherent, entangled and neg-entropic information that can act as an ordering principle in the formation and assembly of cell components and life processes (see pictures in Figures 6 and 7).

A potential vehicle for quantum wave transition in nature, might be envisioned as a torus, enabling compression of information within the geometry of a toroidal field (see also section 5). According to Del Giudice and Vitiello, polarization waves predicted by Fröhlich in living cells are identified as the Goldstone massless modes which appear as a consequence of the spontaneous breakdown of a dipole-rotational symmetry and this breaking is provided by the water polarization induced by Davydov solitons travelling on molecular chains (Del Giudice, 1983). Infrared effects play a crucial role in the dynamical rearrangement of symmetry, which leads to the group contraction (Concini, 1976).

Berges proposed a universality class for longitudinally expanding systems, encompassing strongly correlated non-Abelian plasma's and N-component self-interacting scalars. This occurs in the far infrared (FIR) regime of very high occupancies and leads to the formation of a Bose-Einstein Condensates. This theory can be cast as a vertex-resumed kinetic theory and it has been indicated that the IR dynamics are a non-relativistic system, where a self-interacting scalar field exhibits IR dynamics, reminiscent of turbulent nonrelativistic superfluids in 3+1-dimensions (Berges, 2015). Some of the life frequencies found by us are also reported by Rouleau and Dotta (2014) and are numerically fully in line with our present data.

Both electrons and photons (Williamson, 1997; Y´epez, 2004) have been pictured as toroïdal geometries (Figure 7). A torus consists of a central axis with a vortex at both ends and a surrounding coherent field. Energy flows in one vortex, through the central axis, out the other vortex, and then wraps around itself to return to the first incoming vortex. The torus is the fundamental form of balanced energy flow found in sustainable systems at all scales. The torus as a flow process exhibits a set of characteristics that evolution biologist, Sahtouris (2015) has identified as features and principles of living systems. Through her study, she has observed that when these features are present, the system is balanced and whole. However, when these features become compromised or absent, the system goes out of balance and becomes dysfunctional and corrupted to the point that it will either collapse completely, transform into a new balanced state, or restore its balance again by restoring the appropriate presence and functioning of these features. The features of healthy living systems that Sahtouris identified are: self-creation (autopoiesis, complexity as

diversity of parts, embeddedness in larger holons and dependence on them (holarchy), self-reflexivity (autognosis/self-knowledge), self-regulation/maintenance (autonomics), response-ability to internal and external stress or other change, input/output exchange of matter/energy/information with other holons, transformation of matter/energy/information, empowerment/employment of all component parts, including communications among all parts, as well as coordination of parts and functions.

This type of information integration, interestingly, is also applied in tonal theory (Purwins *et al.,* 2007) and recently in music studies of Van De Bogart and Forshaw, 2015. The latter authors showed that quantum algorithms can be coded through toroidian information compression, using frequency resonance by which information can be encoded in electronic sound that in turn can be decoded to the original information. The particular information processing modality resembles a self-generating imagination that exhibits probabilistic fractal features for storing and retrieving information, thereby attaining a sort of neuroplastic quality. Toroidal flow may, in this respect, be conceived as a modality of rotational information flux, that returns to itself, a characteristic that may be the very basic mechanism for creation of awareness and (self)-consciousness.

If a silicate quantum replicator might have been instrumental in the very starting of life, then a major question is whether there is a relation between the quantum resonances of this replicator, geometries of local fields in and near this replicator and oscillations present in living cells. The science of "geometry" claims that everything in our universe has an underlying geometric structure following a fundamental principle (Wheeler, 1962). The knowledge of "geometry" can be used to explain how physical reality is constructed from the omnipresent and all-pervasive infinite background energy of the physical vacuum (Meijer, 2015). The five Platonic solids, named after Greek philosopher Plato, who first described these 350 years BC in his book Timaeus, were supposed to play a central role.

Charged particles: plasmas, electrons and electromagnetic waves might act as energy carriers, and have influence on geometries of clathrate hydrates. Assembled geometries of ordered phyllosilicates are able to emit coherent quantum resonances and stabilize different kinds of water clathrates (Sposito, 1999). They may also restore the connection and the access to natural fractal waves and natural quantum dynamics, by locally generating a natural pattern of quantum resonances. These patterns can be disturbed by noise of the surroundings as 'non thermal non-ionizing radiation'. The different incorporated doped ions, and paramagnetic ions as well as the geometry of crystals of these silicates, are responsible for these coherent oscillations and obey to geometries/oscillations.

By emitting simultaneously quantum waves according to the resonant frequencies of the algorithm, inferred by us, a toroidal field of resonances in a natural plasma might be generated and stabilized, of which the assembly of resonances closely approaches a Fibonacci sequence: 1, 2, 3, 5, 8, 13… . Therefore, we may be living in a diluted plasma with natural coherent quantum resonances making use of the principles of eigenfrequencies and orthogonal eigenvectors of symmetric matrices, which can be described by equations of standing and longitudinal waves, using ratios of a 'tempered Pythagorean tuning', based upon ratios of 1:2, and approximated ratios of 2:3, 3:4 showing constructive interference and circular rotation, due to relative phase shifts.

The evolution of proto-biotic or primitive non-living units, to even a minimal constitution of a real first life cell (Figure 7), was obviously not a single step as pictured, but rather an extremely long feedback sequence of subtle perturbations, induced by interaction with the environment, that finally gave rise to self-sustaining and replicating cells. In this process a number of features were gradually integrated: inclusion and further development of dynamic metabolic processes, including their timing and network organization, encapsulation of various essential organelles, including their functional localization in the cell, as well as the internalization and/or synthesis of required sensor and ion-channel molecules for internal and external communication. Additional instrumentation includes also a microtubule/ microfilament apparatus for the capability of self-movement, in addition to information storage and retrieval modalities, forming a kind of primitive cellular memory. The biological organization of cellular life, in our opinion, is directly related to primordial information from the quantum vacuum (see also Grandpierre, 2014), that among others, is transduced by the clay mineral quantum replicator and exposed to the proto-biotic elements.

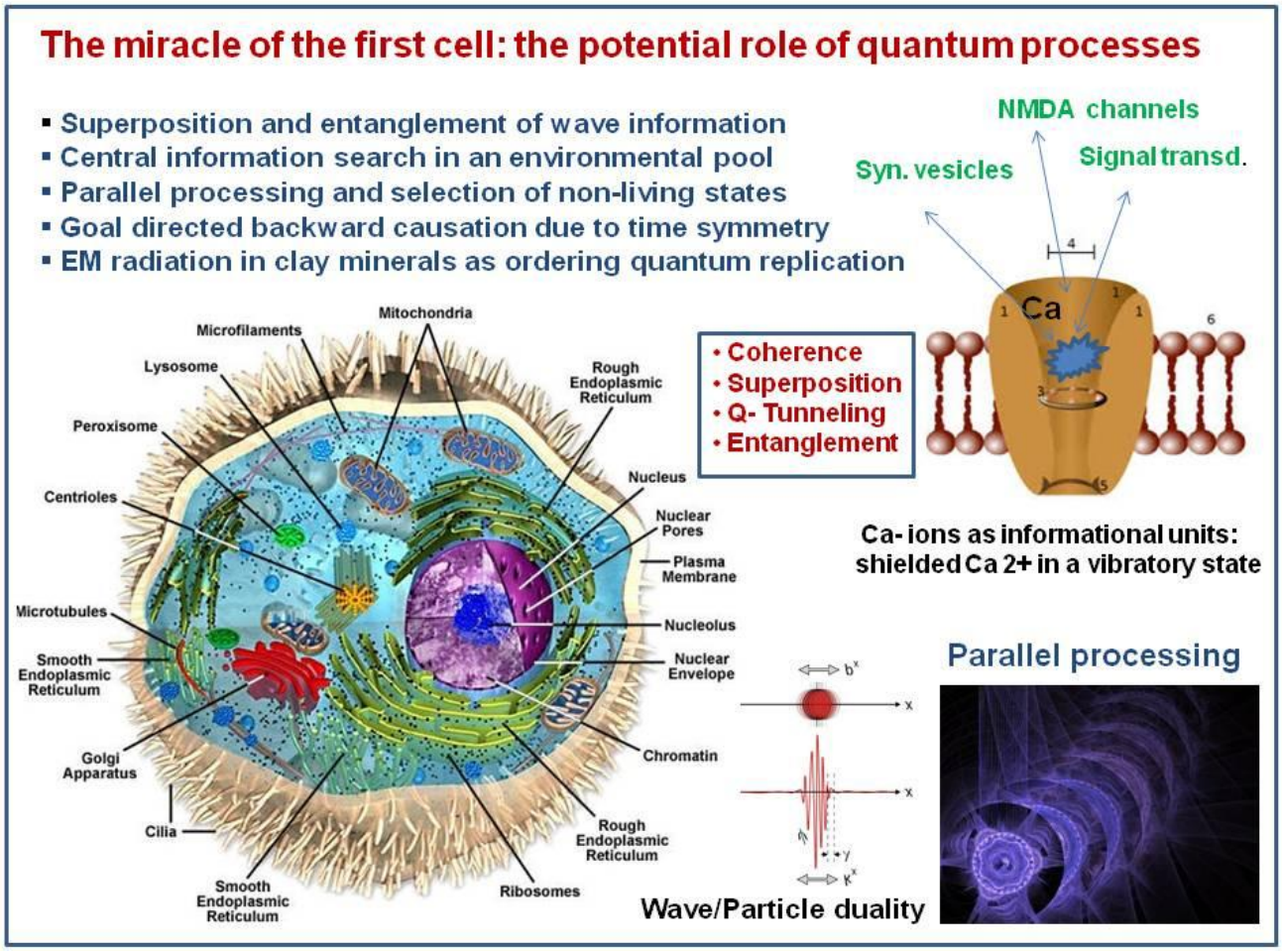

Figure 6. Non-trivial quantum processes in the creation of first replicating cells (left above), including parallel processing (inset right below) and complexity ordering as mediated by coherent EM radiation patterns. Inset, right above, depicts Ca2+ channel protein that is present at various locations in neuronal structures, as an example of a de-coherence shielded compartment, that allows coherent vibrations and thereby enables quantum wave transitions. Quantum phenomena such as superposition, tunneling, entanglement and time-symmetric backward causation may be instrumental in environmental information search and parallel processing/selection.

All this required the assembly of correlations that may have been enabled by the specific properties of fundamental quantum processes in all of these components, such as coherency, circular rotation, entanglement, quantum-tunneling, and non-locality (see Figure 6), including potential goal-directed backward causation, (Meijer, 2012). We consider the induction of quantum coherent domains in the cytoplasm and/or vibrational macro-molecules in organelles, as instrumental in these processes. In this respect, we propose that the resonance with EM frequency wave patterns of coherent environmental matrices such as typical clay-minerals, including intermolecular resonances of water molecules (Figure 7 A), might have had a non-trivial role as a prime organizational and ordering principle (see also Bischof and Del Giudice, 2013).

These frequencies are coupled to geometrical structures and conformational states of water molecules, act at characteristic monochromatic terahertz resonances and might influence the folding of biopolymers. According to the theory of Del Giudice *et al.*, (1990), there is energy exchange between quantum resonances, electromagnetic waves and the so called vacuum or 'zero-point field'. Quantum fluctuations and coupling between matter and electromagnetic fields in quantum-electro-dynamics predicts quantum coherence for liquid water even under ordinary temperatures and pressures. Their theory suggests that interaction between the vacuum electromagnetic field and liquid water induces the formation of large, stable coherent

domains of about 100 nm in diameter at ambient conditions, and these domains may be responsible for the special properties of water including life itself.

This implies that through the implicit feedback reaction from living organisms to the field, a sort of dynamic space-memory, outside the becoming life systems, might be permanently renewed and actualized. This enables parallel search procedures in nature as well as backward causation (also seen as nature's "precognition" capability). In the latter phenomenon weak quantum measurement may play a role, in which future events may influence the past (Meijer, 2012). The functional structure of a living cell can therefore be viewed upon as a bundling of useful in-formation in which the entropic forces are counteracted by neg-entropic (syntropic) modalities. The latter originate from interactions with the direct environment as well as with long distant EM forces, including the zero-point quantum energy field, containing the final space memory for the recipe of life.

We propose that the underlying order, mentioned by Bohm, Fröhlich and Del Giudice, is also coupled to typical resonances of charged particles/electrons characteristic for the Rydberg states of nearly all elements present in the ionosphere, higher atmosphere, including top-layers of the earth, of which assemblies of resonances states are able to generate patterns of vortices and toroid's in a natural quantum field. Noise like 'non thermal/non ionizing radiation' and chemical pollution are able to disturb these patterns, while typical silicate minerals acting as quantum replicators emit coherent resonances with power densities of around 0.0001 μW/m2 and are able to stabilize these patterns.

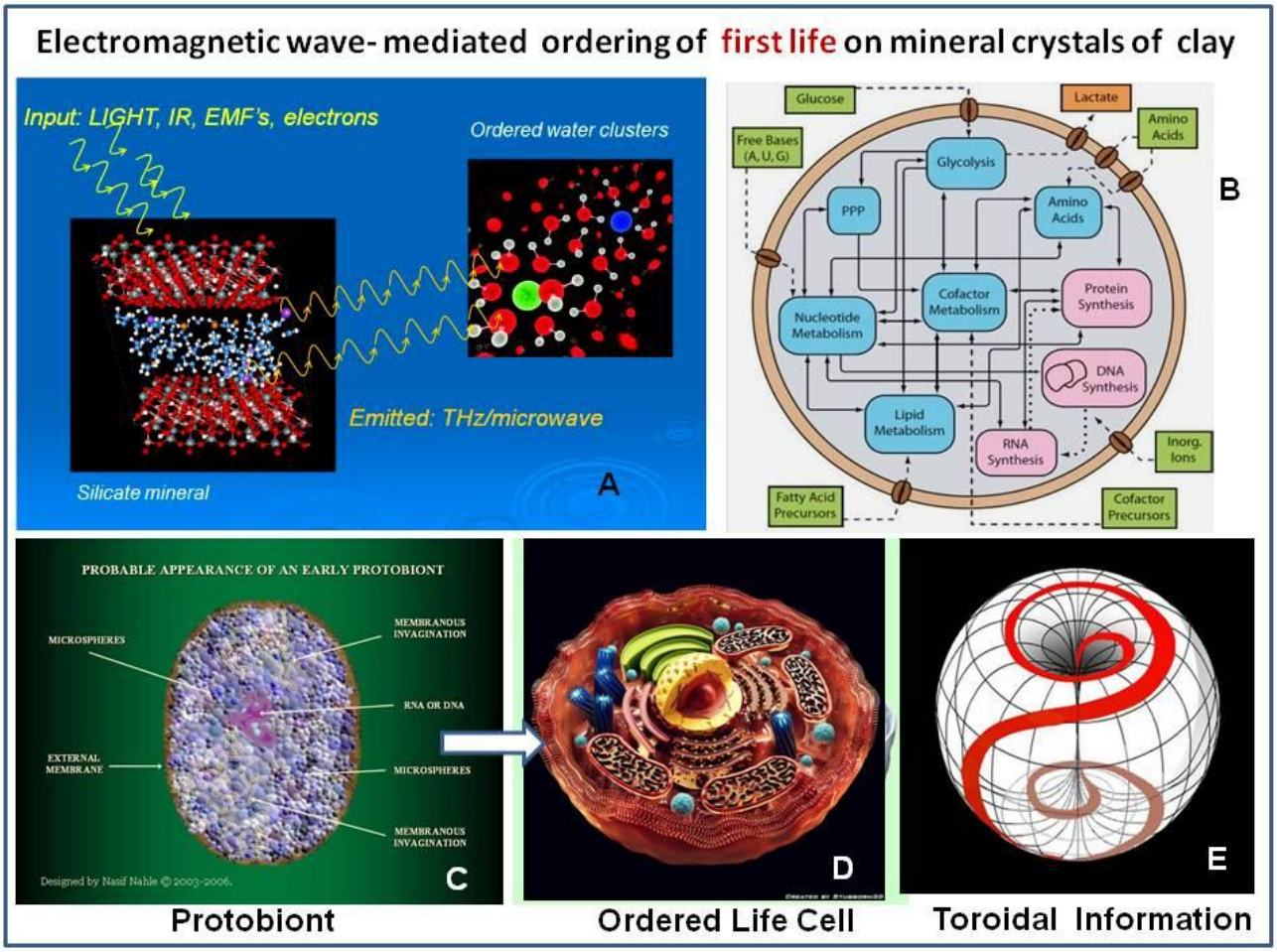

Figure 7. The potential influence of coherent EM radiation frequencies, as an ordering principle in the creation of first viable replicating cells through ordering of water clusters (A). A minimal cell model is shown in (B). Ordering of essential cell components and metabolic processes from proto-biontic structures to an ordered life cell, is shown (C) and (D). Clay minerals mediate EM absorption and EM quantum transmission as natural quantum replicators. Toroidal data compression and transmission in the life system, is required for further processing of the coherent signals (E).

5. Coherent quantum waves in relation to brain function and consciousness

Many scientists have proposed that there is a relation between consciousness and quantum physics (reviewed by Atmanspacher, 2011; Vanini and DiCorpo, 2008; Meijer and Raggett, 2014). Parallels between quantum mechanics and mind/body dualism were first drawn by the founders of quantum mechanics including Erwin Schrödinger, Werner Heisenberg, Wolfgang Pauli, Niels Bohr, and Eugene Wigner. Bohm stated that consciousness is not only present in animate life forms but also in inanimate matter since, energy, space, time and consciousness are not separate things. Umezawa proposed that quantum field theory (QFT) has a role in the working of the brain (Riccicardi and Umezawa, 1947; Stuart, 1978). Synchronous and coherent firing at certain frequencies is related to the state of consciousness and attention. Gamma wave oscillation at 40–80 Hz is supposed to be related to attention and perception, while there is a relation with an internally generated magnetic field (Singer, 1998; McFadden, 2007; Cherry, 2003; Tarlaci, 2015).

Brain function requires complementary information processing mechanisms both at iso-energetic and quantum levels, enabling bottom up and top down information processing, which requires a nested organization of fine-tuned neural micro-sites that enable coherence/de-coherence transitions as a basis for information transfer (Meijer, 2014). It has also become clear that the brain should not be seen solely as a collections of neurons, but rather as a fractal network of a tripartite structure of neurons, glial cells and astrocytes, that intensively communicate, among others by Ca2+ fluxes (Pereira, 2010; Bieberich, 2012), even explaining the mechanism of general anesthesia (Thrane *et al.,* 2012). For a rapid and causally effective flux of information, as well as a continuous updating of a personal information domain, a "bi-cyclic" mental workspace was conceived, housing interacting and entangled wave and protein-based transitions that build-up and retrieve information from a universal knowledge domain (Meijer, 2014).

Such a cyclic mental workspace could operate at the atomic/molecular and field levels. One example of such a potential bidirectional information flow, is based on a central role of Ca2+ ions under the control of various neuronal proteins (Pereira and Furlan, 2011). In this concept Ca2+ is viewed upon as an informational vehicle influencing the activity state of the neuron, (Figure 8). Similar schemes could be imagined for other molecular mechanisms, mediating the tuning of cellular activity into large scale patterns, in the context of the creation of higher mental functions. As potential candidates, the hydrogen atom in relation to H_2O and unpaired electron spins as present in in DNA, other metal ions and even O2 and NO molecules (if associated with membrane proteins), have been proposed (Hu and Wu, 2004).

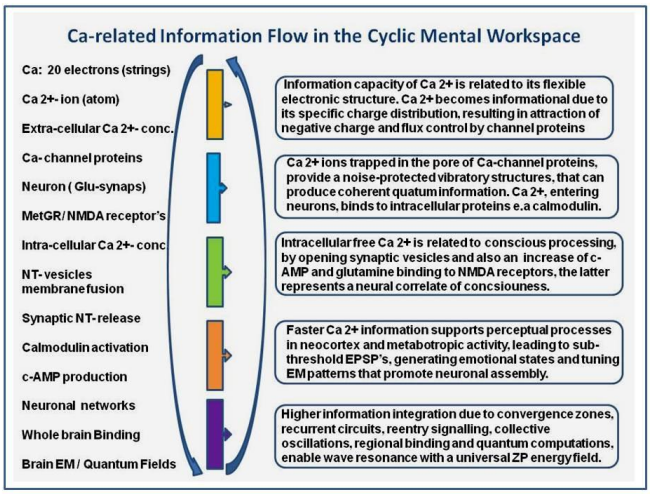

Figure 8. The potential role of Ca2+ ions in the bottom-up and top-down information flow from the micro- to macro-level in the neuronal organization of the brain, as related to higher cognitive functions and consciousness (after Meijer, 2014).

The informational aspect of Ca2+ is encoded in positive and negative charges within micro-sites on the surface of a spectrum of flexible macromolecules, that allow binary choices at various spatio-temporal levels (see also Bieberich, 2012). The latter may also depend on ultra-rapid conformational changes in proteins in pico-seconds, as influenced by locally induced electromagnetic fields, that thereby obtain a probabilistic electro-magnetic vibratory character, an aspect that could also play a role in the earlier presented brain model (Meijer, 2015). In turn, local magnetic fields influence neural firing patterns and induce regional convergent zones of brain activity that are produced through sub-threshold excitatory postsynaptic potentials (EPSP's) and inhibitory inter-neuronal synaptic activity, being amplified by reentry and recurrent circuitry (Pereira and Furlan, 2007). The importance of Ca2+ waves in fast strategic search algorithms, in a sort of bio-reaction quantum computing was earlier stressed by Clark (2012).

Total brain activity is therefore determined by genetic and epigenetic information, neuro-plasticity, as well as functional cycles of efferent and afferent signals (internal copies and external mirror information), that reflect the interaction with the whole body and its environment and dynamically produce our inner worldview, earlier referred to as a "personal universe".

Of note, much of the sequential steps depicted are situated in *single neurons.* Yet, our model, in higher-order levels, requires an integrating modality in which the firing patterns of millions of neuronal networks are translated in a meaningful overall coherent brain response. Sensory processing involves the formation of wave packets affecting large populations of neurons, instrumental in the reciprocal *broadcasting* of excitatory patterns located at several brain regions (Freeman and Vitiello, 2006), and inducing neuronal assembly. Interestingly, in this process calcium waves along the astroglial syncitium may play a role, contributing to collective oscillations and synchrony and thereby to efficient binding of distributed neuronal activity.

Proper information integration, transmission and exchange with outer information domains requires a guided interactive quantum process, in which the classical separation of sender and receiver is overcome through an act of measurement and/or proper resonance with the information source. This implicitly should be based on the phenomenon of entanglement and consequently on unitary and conscious field properties of the neural and exo-systems (McFadden, 2007; John, 2001; Bohm and Hiley, 1987). This allows the continuous exchange of meaningful information with global magnetic fields as proposed by Mc Fadden, 2007 and Burke and Persinger, 2013 and also a universal quantum knowledge field, as earlier proposed by Bohm and Hiley, 1987. The latter "implicate order" concept was suggested to contain also "personal" information: conceptualized as our mental double in the universal consciousness domain (Vitiello, 2001).

McFadden, 2007, proposed that the digital information from neurons is integrated to form a conscious electromagnetic information (CEMI) field in the brain. Consciousness is suggested to be the component of this field that is transmitted back to neurons, and communicates its states internally. The EM field is supposed to recruit neurons into local networks, thereby increasing the synchrony of neuronal firing, a phenomenon that is generally seen as correlating with consciousness. Thoughts are viewed as electromagnetic representations of neuronal information, and the experience of free will in our choice of actions is argued to be our subjective experience of the CEMI field, acting on our neurons. Pockett, 2012, however, implied that the EM field in our brain stands on its own, in the sense that it is generated by electricity of the brain, but does not influence the neural system in a broad feed-back reaction. Rather our EM field communicates bi-directionally with a global EM field, via wave resonance (see also Keppler, 2012, 2013, in the following). Pockett (2012) suggested that the EM field comprises a universal consciousness, that experiences the sensations, perceptions, thoughts and emotions of every conscious being in the universe.

The neuronal network clearly affords a dynamic vibrational structure, as present in membrane channel proteins (Bernroider, 2003), micro-tubular proteins (Hameroff and Penrose, 2013), as well as in DNA (Grandy, 2013). It is hypothesized by us, that this information-receptive neuro-system mirrors the antenna-like structures, described by our algorithm, as it is also present in organized quantum trans-conducting clay materials, were first life was supposedly initiated. In this respect Vattay and Kaufmann (2015) stated that "One of the fascinating aspects of life is the highly organized molecular machinery taking care of myriads of complex processes such as DNA replication, protein synthesis, cell division and metabolism, to mention only a few. Electric forces animating the parts require a perpetual and precise motion of charges throughout the system for perfect execution of biochemical tasks. Practically biomolecules, from small signaling molecules, to proteins and DNA surrounded by ions and water clathrates can take part in biochemical electronic processes, and belong to a class of molecules having semiconductor-like properties at physiological temperatures. Quantum order of semi-conductors exists when the different energy bands that corresponds to the different dopant types have been tuned".

Keppler (2012; 2013) postulated that "the brain produces a stream of consciousness by periodically modifying the Zero-point energy field (ZPF, see for the latter Rueda and Haisch, 1998; 2005) and generating ZPF information states, within this all pervasive radiation field (De la Pena

and Cetto, 1994; 2001). This process takes place by transient gamma-band oscillations and synchronization of cortical regions of our brain. These long-range activity patterns may represent the neural correlate of consciousness. The regular perceptual process, the alternation of synchronization and de-synchronization is supposed to be linked to theta oscillations. Whenever the brain activity falls into a stable attractor, there is a corresponding ZPF information state, which carries the integrated information of the attractor and might be characterized by specific correlations between frequency components of a ZPF spectrum. Every ZPF information state, in this concept, is associated with a conscious state, i.e., every ordered pattern in ZPF information space corresponds to a phenomenal state in qualia space. The brain together with the different neurological systems evidently provide an environment that is sufficiently stabilized against thermal noise, making the ZPF an agent and communication medium that orchestrates finally the brain activity. This indicates that the *recurrent* formation and dissolution of quantum states may constitute a fundamental mechanism in the brain. ZPF, therefore, seems to be a promising candidate for the carrier of consciousness".

Consciousness, therefore, might be a fundamental property of universe itself, and our individual consciousness may constitute the result of a dynamic interaction process that causes the realization of ZPF information states (Keppler, 2012). This also implies that matter and consciousness have a common basis in the ZPF, and enable the orchestration of matter. The brain is viewed upon to be a complex instrument that selects and filters the varied shades of sensations and emotions out of the all-pervasive field of consciousness, the ZPF. Every attractor might act as a typical resonator and filter on the ZPF, and generates a characteristic frequency pattern, thus specifying a particular ZPF information state that is associated with a conscious state. In this way the brain may produce an individual stream of consciousness by periodically attracting information from the ZPF and, in turn, generating ZPF information states. Based on the hypothesis that the ZPF is the carrier of consciousness, only systems, that interact dynamically and coherently with the ZPF, while generating ZPF information states, are seen as sustainable, according to this interesting theory. Keppler states that, especially, complex systems, that have rich and highly adaptive attractor landscapes, can give rise to a broad spectrum of conscious experiences. The latter idea bears resemblance with the integration of information model for consciousness of Tononi, 2008.

6. Conclusions and final discussion

Electromagnetically seen, we may be living in a "diluted plasma" with natural coherent quantum resonances, that can be approached by equations for standing waves as present in strings, at 1:2 ratios and approximated 2:3 frequency ratios according to an algorithm of scalars. We propose that a natural quantum field makes use of, invariable, 12 typical basic quantum resonances, positioned in an algorithm, of which FIR frequencies are central basic frequencies, next to lower and higher coherent frequencies. The energy of these quantum resonances is around kT, and sufficient stable due to the entanglement of the algorithmic frequencies, and present in natural resonances positioned in frequency bands of: ELF, LF, HF, IR, Light, and UV. Natural resonances are supplied by metamaterials and Rydberg states of excited atoms and molecules. Metamaterials such as typical clay minerals act in concert with water molecules, and are able to transfer their FIR resonances to a diluted plasma, as the substrate of a quantum field. Also Rydberg excited atoms and molecules in the higher atmosphere at microwave and FIR frequencies transfer their resonances to stabilized water clusters, of which is known that there is a direct influence on biological effects (Avakyan, 2004).

All applied frequencies mentioned in the independent biological studies approach the proposed algorithm, within a small bandwidth. The overall mean distance (bandwidth) between the applied biological frequencies (97 different frequencies) and the preferred frequencies of the mathematical algorithm is 0.78%, which means that these waves are coherent. There is also a good statistical frequency match for a typical silicate mineral in the category that is able to catalyze RNA, as a proof of principle. Interestingly, there is also a striking match with color frequencies used in the photosynthesis of plants and algae, and a non-coherent blue-frequency showing phototoxic effects on the human eye health.

There is a good agreement with the 'tone and color analogy' proposed by Von Helmholtz,

when the frequency 432 Hz instead of 440 Hz is used. The proposed tone scale by Furia, approaches the algorithmic frequencies, while the eigenfrequencies of so called Chladni patterns in square plates show a quantitative resemblance. The proposed equation of the algorithm resembles the proposed equation of Šrobár to use a one-dimensional equation with two whole numbers as a Fröhlich ensemble of interactions counting two or three coupled oscillators (Šrobár, 2012). The model fits with the proposal of Ogryzko that 'preferred states' in biological systems can be protected from environmentally induced decoherence exactly, because they are 'preferred states' surviving interaction with the environment (Ogryzko, 2008). The relation found between the order of the quantum states in the selected silicate minerals and typical coherent frequencies applied in 175 independent biological studies, analyzed by us, shows that, at a quantum scale, there exists a similar underlying order, comparable to electromagnetic waves. It can now be considered that this order in nature is present in distinct quantum states as well as in electromagnetic wave patterns. We propose that in the present study, a potential template of oscillations is identified, as predicted in the book *"What is Life"* (Schrödinger, 1944).

If our proposed mathematical algorithm is operable in nature, then we may question the very reason for its existence. If a pre-quantum state or a "backfield" is considered, in which electromagnetic fields are quantized in the process of interaction with matter, according to this algorithm, then the matter involved has to be defined (Tegmark, 2007). We consider the possibility that a spectrum of silicates presents in the form of naturally occurring nano- and micron-particles and Rydberg states of atoms, as well as in molecules in gas clouds, support the implied oscillations. Such modalities are present in the cosmos, in layers of the earth, as well as in the higher atmosphere. Quantum resonances are supplied by these minerals, creating and/or stabilizing a quantum field, that can be characterized by frequencies described by the algorithm, in which stability of biological order can be maintained. In this concept, water molecules play an important role. Water is not only the medium for the reaction of biomolecules, but also the medium to spatially arrange molecules, and to keep their coherence (Del Giudice, 2009). Water is known to be nano-structured, affecting bio-molecular processes, including protein stability, substrate binding to enzymes, as well as electron and proton transfer. THz vibrational modes communicate by phonons via coupling of THz-frequencies to large water clusters due to electric dipole moments. By making use of wave information, on the basis of the proposed algorithm, this can lead to quantum coherence and Bose-Einstein-like condensation of such interacting water clusters.

Assumed that the here proposed algorithm is instrumental in a type of ordering, along with aspects of entanglement and fractality, there might be a link with multi-dimensional field dynamics. Multi-dimensional fields have been considered by many physicists: B. Riemann, for example, developed a general characteristics of non-Euclidean geometries in 1854, including curved spaces and higher dimensional geometry of manifolds. Chew proposed a three-dimensional tone model, in which tones are lined up on a helix along the circle of fifths (2:3), while Purwins showed double circular relations of the major and minor keys, based on all twelve pitch classes, which, interestingly, can be depicted in toroidal models (Chew, 2000; Purwins, 2007). It is considered by us that the described coherent quantum waves and their geometries are able to constitute vortices and toroidal like flow structures (Figure-7), which might be conceptualized as quanta flux of dark matter. It is expected that a 3D- ordering of frequencies at 1:2 and closely approaching intervals of 2:3, can be mathematically described to enable the calculation of a coherent 3-D geometry of standing waves with well-defined eigen-frequencies. The particular 3D geometry might also enable an entrance to a 4-D geometry (to be published).

The primary waves in a plasma of a quantum wave field that are able to realize biological order, can therefore be coupled to standing waves and circular rotation among at terahertz frequencies. Waves in the so-called terahertz-gap are able to transfer energy between photons as well as electrons.

The underlying physical principles of the influence of 'non thermal/ non ionizing radiation' on living organisms are still not fully known, but a better insight in the underlying algorithm may give us further clues. We showed that 'non thermal' coherent frequencies, obeying the inferred algorithm, are able to stabilize cells, while frequencies just in between the proposed coherent frequencies, clearly destabilize these

cells. Of note, the geometrical study of the handling of quantum information is more fruitful when the global evolution of a system is taken into account, without disturbing its non-local nature, (Tarlaci, 2015).

To summarize, we propose that the frequencies, described by the algorithm identified in the present paper, are characteristic for the oscillations of a quantum field, in which we are living. Phyllo-silicates may therefore have been instrumental in biological evolution, since they can represent an ongoing dynamic constituent in the circular organized fabric of reality and evolution of consciousness. (Meijer, 2015).

As far as we can see now, we may have identified a quantum electrodynamic basis for life, that we tentatively hypothesize as a non-trivial building block for an electromagnetic principle in molecular biology. We are presently collecting further supporting physical and mathematical evidence for our hypothesis, surveying a spectrum of biophysical phenomena, exhibiting similar coherent wave patterns, as instrumented by toroidal information geometry.

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Appendix 1

Literature on the biological studies used for deriving the "life algorithm"

Authors of biological studies of frequencies applied to cells: beneficial effects

Helmholtz, 1863, 1867, Wright 1946, Ichimura, 1960, Fröhlich, H, 1968, Moore, 1979, Blackman, 1979, Braun, 1982, Murray, 1985, Blackman 1985, Pohl, 1986, Aaron, 1987, Singer and Gray, 1989, Hood, 1989, Tabrah, 1990, Battini, 1991, Cane, 1993, Reed, 1993, Ciombor, 1993, Rannug, 1993, Reite, 1994, Nazar, 1994, Hameroff and Penrose, 1996, Yu, 1997, Palacios, 1997, Santoro, 1997, Belyaev, 1998, Loschinger, 1999, Singer, 1999, Chrobak, 2000, Kitchel, 2000, Sanchez-Vives, 2000, Paksy, 2000, Belyaev, 2001, Whelan, 2001, Schmitz, 2001, Douglas, 2001, Varani, 2002, Pereira, 2002, Ghannam, 2002, Buhl, 2003, Foffani, 2003, Reddy, 2003, Tomany, 2004, Cheron, 2004, Mayrovitz, 2004, Byrnes, 2004, Nascimento, 2004, Moore, 2005, Fadel, 2005, Beneduci, 2005, Weiss, 2005, Cameron, 2005, Maiya, 2005, Glazer-Hockstein, 2006, Rabelo, 2006, Carvalho, 2006, Algvere, 2006, Lisi, 2006, Viegas, 2007, Chen, 2007, Lanzafame, 2007, Huang, 2007, Tomany, 2007, Araújo, 2007, Mirzaei, 2007, Yasukawa, 2007, Hawkins, 2007, Rezende, 2007, Sukhova, 2007, Selvam, 2007, Stolfa, 2007, Zou, 2007, Golgher, 2007, Wei, 2008, Vianale, 2008, Houreld, 2008, Reis, 2008, Lisi, 2008, Gungormus, 2009, De Mattei, 2009, Pokorny, 2009, Ursache, 2009, Matic, 2009, Tada, 2009, Hartwich, 2009, Komine, 2010, Lacjaková, 2010, Ricci, 2010, Gonçalves, 2010, Pikov, 2010, Kalantaryan, 2010, Chung, 2010, Nemova, 2010, Meyer, 2010, De Sousa, 2010, Weng, 2011, Wu & Persinger 2011, Adamskaya, 2011, Fedorov, 2011, Wen, 2011, Lim, 2011, Silveira, 2011, Arns, 2011, Silveira, 2011, Hussein, 2011, Gupta (Hamblin) 2012, Choi, 2012, Eusebio, 2012, Fushimi, 2012, Kirichuk, 2013, Pugliese, 2013, Tao Lei, 2013, Cheon, 2013, Shin Kang, 2013, Takebe, 2013, Fahimipour, 2013, Smick, 2013, Fröhlich, F., 2014, Segatore, 2014, Leoci, 2014, Veronesi, 2014, Sancristóbal, 2014, Bastos, 2014, Hernández-Bule, 2014, Rouleau & Dotta, 2014, Cheing, 2014, Sahu and Bandyopadhyay, 2014, Seeliger, 2014, Reale, 2014, Ceccarelli, 2014, Ross, 2015, Lai and Pittelkow, 2015, Bogomazova, 2015, Blumenfeld, 2015, Persinger, 2015.

The complete reference list of the 175 surveyed biological studies, is available from the authors via mail request.

Appendix 2

Condensate frequencies according to the "mathematical" algorithm

4-8 Hz:
4.0, 4.22, 4.5, 4.74, 5.06, 5.33, 5.70, 6.0, 6.32, 6.75, 7.11, 7.59 Hz

32-61 Hz:
32.0, 33.7, 36.0, 37.9, 40.5, 42.7, 45.6, 48.0, 50.6, 54.0, 56.9, 60.75 Hz

64-122 Hz:
64, 67.5, 72, 75.78, 81, 85.3, 91.18, 96, 101.1, 108.0, 113.8, 121.5 Hz

255-487 Hz:
256, 269.8, 288, 303.1, 324, 341.2, 364.7, 384, 404.5, 432, 455.1, 486 Hz

16.3-31.2 kHz:
16.38, 17.25, 18.43, 19.40, 20.74, 21.84, 23.34, 24.58, 25.91, 27.65, 29.13, 31.10 KHz

16.7-32 MHz:
16.77, 17.66, 18.87, 19.86, 21.24, 22.36, 23.90, 25.17, 26.53, 28.31, 29.83, 31.85 Mhz

4.2-8.2 GHz:
4.293, 4.520, 4.831, 5.085, 5.437, 5.724, 6.119, 6.443, 6.792, 7.247, 7.636, 8.154 GHz.

1.1-1070 THz:
1.10, 1.158, 1.237, 1.302, 1.391, 1.466, 1.566, 1.649, 1.738, 1.855, 1.955, 2.088 Thz
2.20, 2.316, 2.474, 2.604, 2.783, 2.931, 3.133, 3.298, 3.475, 3.710, 3.909, 4.175 THz
4.40, 4.633, 4.948, 5.208, 5.566, 5.863, 6.266, 6.597, 6.950, 7.420, 7.819, 8.350 Thz
8.80, 9.266, 9.897, 10.42, 11.13, 11.73, 12.53, 13.19, 13.90, 14.84, 15.64, 16.70 THz
17.59, 18.53, 19.79, 20.83, 22.26, 23.45, 25.06, 26.39, 27.80, 29.68, 31.28, 33.40 THz
35.19, 37.06, 39.59, 41.66, 44.53, 46.90, 50.13, 52.78, 55.60, 59.36, 62.55, 66.80 THz
70.38, 74.13, 79.18, 83.33, 89.05, 93.80, 100.3, 105.6, 111.2, 118.7, 125.1, 133.6 THz
140.8, 148.3, 158.4, 166.7, 178.1, 187.6, 200.5, 211.1, 222.4, 237.5, 250.2, 267.2 THz
281.5, 296.5, 316.7, 333.3, 356.2, 375.2, 401.0, 422.2, 444.8, 474.9, 500.4, 534.4 THz.
562.9, 592.9, 632.7, 666.5, 712.4, 750.4, 802.0, 844.4, 889.6, 949.8, 1000.8, 1068.8 THz

Appendix 3

EM frequencies extracted from the biological studies, versus the calculated (via mathematical algorithm) derived frequencies

Depicted are: Applied biological frequency (x), Calculated mathematical algorithm frequency (y) and Difference in % (z): (x; y; z).

Positive effects (x; y; z):

Hz:
0.445; 0.444; -0.23%
0.473; 0.474; -0.21%
0.482; 0.474; +1.69%
0.499; 0.500; -0.2%
0.750; 0.750; 0.00%
1.000; 1.000; 0.00%
2.000; 2.000; 0.00%
3.200; 3.160; +1.27%
4.000; 4.000; 0.00%
4.500; 4.500; 0.00%
5.000; 5.063; -1.24%
5.500; 5.330; +3.19%
6.000; 6.000; 0.00%
7.000; 7.100; -1.41%
7.500; 7.590; -1.19%
7.800; 7.590; +1.46%
8.000; 8.000; 0.00%
9.000; 9.000; 0.00%
10.00; 10.10; -1.00%
20.00; 20.20; -0.99%
13.50; 13.50; 0.00%
15.00; 15.19; -1.25%
16.00; 16.00; 0.00%
17.10; 16.90; +1.18%
20.00; 20.25; - 1.24%
33.00; 33.70; -2.08%
37.50; 37.90; -1.06%
40.00; 40.50; -1.24%

40.50; 40.50; 0.00%
42.70; 42.70; 0.00%
45.00; 45.60; -1.32%
48.00; 48.00; 0.00%
50.00; 50.60; 1.19%
54.00; 54.00; 0.00%
60.00; 60.75; -1.24%
72.00; 72.00; 0.00%
75.00; 75.78; -1.01%
76.00; 75.90; +0.13%
91.00; 91.18; -0.20%
100.0; 101.1; -1.09%
110.0; 108.0; +1.85%
120.0; 121.5; -1.24%
150.0; 151.6; -1.06%
160.0; 162.0; -1.24%
200.0; 202.2; -1.09%
300.0; 303.1; -1.02%

kHz:
33.00; 32.76; +0.73%
35.00; 34.50; +1.45%
448.0; 442.4; +1.27%

MHz:
0.500; 0.498; +0.40%
1.000; 0.995; +0.50%
1.500; 1.490; +0.67%
3.000; 2.990; +0.33%

3.770; 3.730; +1.07%
5.000; 4.970; 0.60%
8.000; 7.960; 0.50%
20.00; 19.90; 0.50%
21.20; 21.24; 0.19%

GHz:
46.00; 45.79; +0.46%
51.05; 51.54; -0.95%
60.13; 61.09; -1.57%
61.20; 61.09; +0.18%
64.50; 65.23; -1.12%
65.00; 65.23; -0.35%

THz:
0.129; 0.1305; -1.15
2.300; 2.316; -0.69%
3.680; 3.710; -0.81%

Nm:
254; 252.8; +0.48%
340; 337; +0.89%
390; 399.5; -2.38%
393; 399.5; -1.63%
395; 399.5; -1.13%
404; 399.5; +1.13%
415; 420.8; -1.38%
420; 420.8; -0.19%
445; 449.8; -1.07%
450; 449.8; +0.04%
452; 449.8; +0.49%
456; 449.8; + 1.38%
470; 473.8; -0.80%
515; 505.6; +1.86%
503.96; 505.6; -0.32%
505.86; 505.6; +0.05%
530; 532.5; -0.47%
532; 532.5; -0.09%
560; 561.0; -0.18%
590; 599.1; -1.52%
605-610; 599.1; +1.40%
627; 631.3; -0.68%
629; 631.3; -0.36%
630; 631.3; -0.21%
632.8; 631.3; +0.24%
638; 631.3: +1.06%
670; 674.0; +0.59%
675; 674.0; +0.15%
700; 710.1; -1.42%
740-750; 747.6; -0.35%

Negative effects:

Hz:
6.600; 6.540; +0.92%

MHz:
835.0; 827.2; +0.94%

Ghz:
2.450; 2.479; -1.17%
9.417; 9.351; +0.71%