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Meijer and Geesink., Phonon guided biology

Phonon Guided Biology: Architecture of Life and Conscious Perception Are Mediated by Toroidal Coupling of Phonon, Photon and Electron Information Fluxes at Discrete Eigenfrequencies

Dirk K. F. Meijer and Hans J. H. Geesink

ABSTRACT

Recently, a novel biological principle, revealing specific electromagnetic (EM) radiation frequencies that sustain life, was presented by us on the basis of an evaluation of 175 biological articles concerning beneficial effects of electromagnetic waves on the state of living cells. This concept was also based on a very similar range of frequencies emitted by a clay-mineral catalyst of RNA synthesis that may have been instrumental in the evolutionary initiation of first life, and therefore was tentatively designated as "Algorithm of Life". The particular spectrum of frequency bands indicate that nature seems to employ discrete eigenfrequencies or standing waves that match precisely with an acoustic scale, with frequency ratios of 1:2, and closely approximated by 2:3, 3:4, 3:5, 4:5 and higher partials, allowing the discrete frequencies to be expressed in scalars. Our further studies clearly indicate now that this "life algorithm" pattern matches very well with the mathematical calculations of W. Ritz (1909) to compute eigenfrequencies of the sound induced geometric patterns. These have been earlier demonstrated through membrane vibration experiments of E. Chladni (1787), as well as several follow up studies from 1970-2013. Our findings, therefore, touch upon the science of acoustics, also since we show that the discrete frequencies could be modeled by music torus geometry. We postulate that the spectrum of EM frequencies detected, exhibit a quantum ordering effect on life cells on the basis of induction of geometric wave patterns. These constitute phonon/photon and electron wave energies, and quantum oscillations at far-infrared frequencies, that are communicated through toroidal constructive interference into scalar wave information. This idea is supported through our identification of potential intrinsic toroidal eigenfrequencies and minimal energy levels. The particular torus topology for information processing may also provide quantum error correction and protection against decoherence. Finally, we propose a phonon guided organization of cells and integral brain function by three elementary processes: 1) A phonon mediated geometric organization of coherent arrangement of water molecules in cellular plasma, leading to instructive functional organization of cellular structures and metabolic processes and enabling the origination and sustainment of life processes. 2) Toroidal phonon/photon/electron coupling, protecting standing wave coherency of resonant cell components such as proteins and DNA. 3) A toroidal integration of electromagnetic and phononic fluxes of information into scalar standing waves, promoting quantum flux of informational excitons such as Ca2+- ions and electrons (polaron and polariton formation). Our brain, therefore, can be placed in a 4+1 geometry, supported by internal and external quantum states and makes use of geometrical defined information fluxes, that are converted to standing waves. The integration of these interrelated processes is considered to be instrumental in the creation of conscious perception and is proposed to be organized in a fractal, nested, 4-D toroidal geometry.

Key Words: Life Algorithm, EM quantum frequencies, eigenstates/frequencies, toroidal information flux, Ritz calculation, Chladni geometric patterns, ordering of biological systems, phonon/photon coupling, toroidal coherence protection, Ca2+ waves and consciousness, far infrared

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We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T S Eliot (in *Little Gidding*, 1942)

1. Introduction

The physical mechanism underlying the influence of EMF fields in the process of morphogenesis (Sheldrake, 2009) has remained undefined. However, it may be stated that EM fields and quantum states express several of the supposed properties of the morphogenetic field, such as an ability to store (Persinger, 2008; Gang *et al.,* 2012) and transmit information (Dotta *et al.,* 2009; Burke *et al.,* 2013). The geomagnetic field can be viewed upon to be a unifying medium in which the immersed biological structures can share functional properties. Accessing this information would allow a developing organism to order itself into the appropriate structural configuration required to resonate best with the established quantum states contained within the EM engram. Repeating values and critical thresholds would operate as a recurrent flux of coding mathematical information, becoming expressed in a full range of life systems. Chin *et al.,* 2012 argued that biological environments are not merely creating white noise but do actually possess a complex spectral structure. Indeed, an important aspect of biological environments are vibrations which originate from proteins and embedded molecules. At specific frequencies this vibrational motion can be long-lived and interact in highly non-trivial fashion with electronic motion which we proposed to give rise to fast transport, molecular recognition or long-lived quantum coherence in biological systems.

Sahu *et al.,* 2013 have shown apparent quantum resonance effects in single microtubules in kilohertz, megahertz and gigahertz vibrations. Quantum coherence in plant photosynthesis, magneto-reception in birds, the human sense of smell and individual photon effects in vision suggest a significant role for quantum mechanisms throughout biology (Lambert *et al.,* 2013; Huelga and Plenio, 2013). Sensitive detection of external information is possible with dedicated cellular structures through photons, as for instance in the retina that amplify the energy of a single photon by a cascade of processes via changes of protein conformations and potential energy of the retina, leading to neuronal activation. Humans can sense less than ten photons, whereas insects might even detect a single photon (Baylor *et al.,* 1979; Menini *et al.,* 1995). Using biotechnical techniques, photosensitive proteins have been coupled to ion-channel proteins, so that neural activity can be modified or inhibited *in vivo* by photons introduced through optic microfibers (Lima and Miesenböck, 2005; Boyden *et al.,* 2005).

EMF's (electromagnetic fields) can be located externally, but also be present internally in living organisms, for instance being induced by ion-fluxes of Na+, K+ and Ca2+ (see McFadden, 2007; Pockett, 2012; Rouleau, 2014; Pereira, 2011). There are plausible models that indicate that DNA itself can function as an aggregate of EM antennae that could discern, differentiate, and transform EM energies to perturbations in base-pair sequences (Cosic, 1994; Mihai *et al.,* 2014). In addition to this, exposure to magnetic fields can induce effects in microtubule organization (Glade and Tabony, 2005; Craddock, 2012). Only brief exposure to magnetic fields triggered self-organization within the mitochondria, organelles that are central to many cell functions. Cell systems, like mammalian cells, possess the potential for EMF interaction. For example, the depolarization of a neuron produces an influx of Ca2+ ions through the membrane, which is related to the intensity of a magnetic field (Grassi *et al.,* 2004; Pall, 2013). If a physiologically-patterned, intensity-adjusted EMF is applied to the membrane with the exact resonant frequency

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of Ca2+ gated channels, then this EMF application can activate or stimulate the particular cell.

Since water comprises 70% of the brain, quantum brain dynamics (QBD) implies that the electric dipoles of the water molecules are constituted within a local quantum field. The cortical field is postulated to interact with quantum coherent waves generated by the biomolecules in neurons, which are suggested to propagate along the neuronal network (Bishof and Del Giudice, 2013). The idea of quantum coherent waves in the neuronal network derives from Fröhlich (1968, 1969). He viewed these waves as a means by which order could be maintained in living systems, and argued that the neuronal network could support long-range correlation of dipoles. This theory suggests that the cortical field not only interacts with the neuronal network, but also to a good extent controls it. Vitiello (2001), proposed that the quantum states produce two poles, a subjective representation of the external world and also the "internal self".

It has been indicated by several authors that the entire information matrix at stake should be placed in a 4+1 dimensional geometry (4 real dimensions plus one time dimension), in order to allow not only awareness and conscious perception but also the inclusion of self-reflection and self-consciousness. Such a 5-dimensional space-time brane model was proposed in order to adequately position self-consciousness and universal consciousness in the entire cosmos we live in (Carter, 2014a, 2014b), suggesting that consciousness may be partially represented in a so called string brane, rather than only in the brain perse. In contrast, the objective (quantum state) reductions of Penrose (2014), as a basis for qualia and consciousness, were hypothesized to be generated through gravitational resonance with space-time bubble-like separations at the Planck scale. This leads to collapses in fundamental space-time geometry, all the way extending downward to the level of spin networks. Planck scale spin networks thereby would encode proto-conscious ("funda-mental") experience (qualia).

The central question of the present study is: what is the most efficient and versatile vehicle for a faithful transmission of electromagnetic and quantum information in nature and in particular between inanimate and life systems. A series of studies was earlier presented concerning the cyclic flow of information at the various organizational levels of the universe (Meijer, 2012, 2013, 2014, 2015), in which the rotational aspect of information flux was tentatively identified by bi-cyclic/spiral geometry. This informational aspect can be defined as an informational structural framework that takes information as primary and fundamental in the fabric of the universe (Zeilinger, 2003; Vedral, 2012; Wheeler, 1994). Bateson (1979), has argued that "Information" expresses the fact that a system is in a certain configuration that is correlated to the configuration of another system and any physical system may contain information about another physical system.

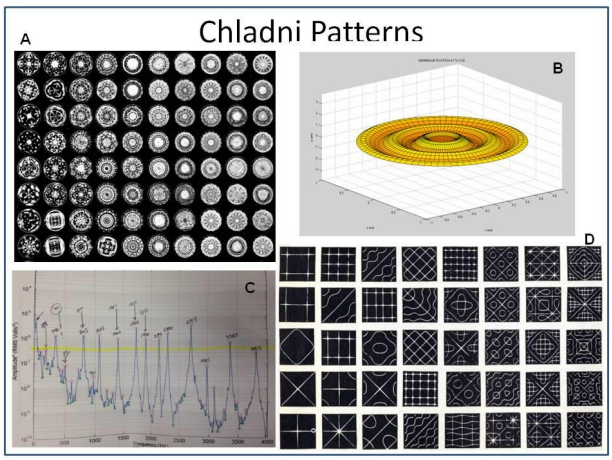

Figure 1. Geometric Chladni patterns of water set in motion by sound, induced on a vibrational plate (A); Vibration of a Chladni disk, Matlab., W. Xiao, 2010 (B); Frequency response plot of a Chladni plate (University of Illinois, 2015, C); Vibrational geometric patterns of sand particles measured by Chladni, 1787 (D).

We propose that nature makes use of typical eigenfrequencies to direct the functional architecture and metabolic networks of cells in living organisms. The word "Eigen" comes from German and means "own", and an eigenfrequency is a frequency at which a system tends to oscillate at its own, in the absence of any driving or damping force. Eigenfrequencies are related to eigenstates, which are dynamic mechanical states of vibrating cells as well as of inanimate materials. The typical frequencies are embedded in symmetric matrices, which are orthogonal. The basic idea, that life can be described by an algorithm, and run by mathematics and physics, is applied in the search for biological creativity

and health. The environment provides organisms with a variety of inputs in the form of both information and matter-energy modalities. As there is no information without representation, all information is carried by physical carriers (light, infrared, chemical molecules, etc.), in a process of structural coupling (Dodig-Crnkovic, 2014). In the following we will treat a number of aspects concerning the potential phonon guided (acoustical) wave system that may influence initiation and sustainment of life, brain function and consciousness by considering:

-The computation of eigenstates of vibrational quantum systems;

-Patterns of the earlier revealed quantum wave information, favorable for maintenance of life;

-The geometric data of Chladni and Ritz, that confirm the detected life principle;

-The chosen torus model that may be instrumental in the proposed phonon guided biology;

-The potential mechanisms for instructive quantum wave effects on life systems;

-Electromagnetic eigenfrequencies in relation to quantum coherence in life systems;

-Phonon guided biology: the role of far infrared quantum states and implication for brain function and consciousness.

2. Computation of eigenstates of vibrational quantum systems

In quantum physics, a system of particles or waves can be described in terms of an "energy functional" or Hamiltonian, which represents the energy of any proposed configuration of particles or waves. A Hamiltonian system is a mathematical formalism to describe the evolution equations of a physical system. In this system certain preferred configurations are more likely than others, which is approached by an eigen-analysis ("analysis of characteristics") of a Hamiltonian system. The advantage of this description is that it gives insight into the particular dynamics, even if the initial value problem cannot be solved analytically.

Because it is often impossible to analyze all of the infinite configurations of particles/waves and to find the one with the smallest content of energy, it becomes essential to approximate this Hamiltonian aspect for the purpose of numerical computations. The mathematician W. Ritz developed a mathematical method in 1909, in order to compute eigenstates and eigenfrequencies. According to Gander and Wanner, the so-called Ritz–Galerkin method is at present a fundamental tool of modern computing. Its origins lie in Hilbert's "direct" approach to the variational calculus of Euler–Lagrange and in the thesis of Walther Ritz, submitted in 1902. Ritz tried to explain the phenomenon of Balmer series in spectroscopy using eigenvalue problems of partial differential equations on rectangular domains (Gander and Wanner, 2012). Ritz also developed a mathematical method in order to compute eigenstates and eigenfrequencies of vibrating thin square plates, such as the membrane studies, documented by Chladni (1787), related to his practical thin plate experiments shown in Figure 1 D and 2 (Ritz, 1909). Instead of trying to solve the partial differential eigenvalues directly, Ritz used the principle of energy minimization, from which the essential equations could subsequently be derived. Ritz elegantly succeeded to calculate the different Chladni patterns and the first 35 eigenfrequencies of these patterns (Figure 2). The mathematicians Gander and Kwok concluded that Ritz was indeed able to calculate the measured Chladni patterns, nodes and antinodes very precisely for a square thin plate, at an amazing accuracy of about 1%, that is for the first 18 measured pattern experiments in the middle range of eigenfrequencies (Gander and Kwok, 2010).

Ritz used the different measured patterns (Figure 1D) and eigenfrequencies of Chladni to verify his calculations. Chladni, being both a physicist and a musician, had discovered a technique, that consists of drawing a bow over a circular or square plate whose surface is lightly covered with small sand particles and described these experiments precisely. When stroked, a given plate will resonate at preferred frequencies. The plate itself was fixed only in the center, and for each tone pitch a coherent pattern of sand particles appeared. Chladni collected all the figures he was able to create, and made drawings of each, (Figure 1D). The sand bounces about on the plate until settling at nodal points (areas of zero movement) thereby producing coherent patterns, now called Chladni figures. He discovered that the pitches and the different patterns agree approximately with the squares of

the numbers: 1, 2, 3, 4, 5, 6, 7, and 8. And that there are increasing numbers of ways to get higher eigenfrequencies by mixing different numbers of circles and lines, visible as nodes in the patterns. He also realized that various sounds coexist in the vibration of the same body (Figure 1A).

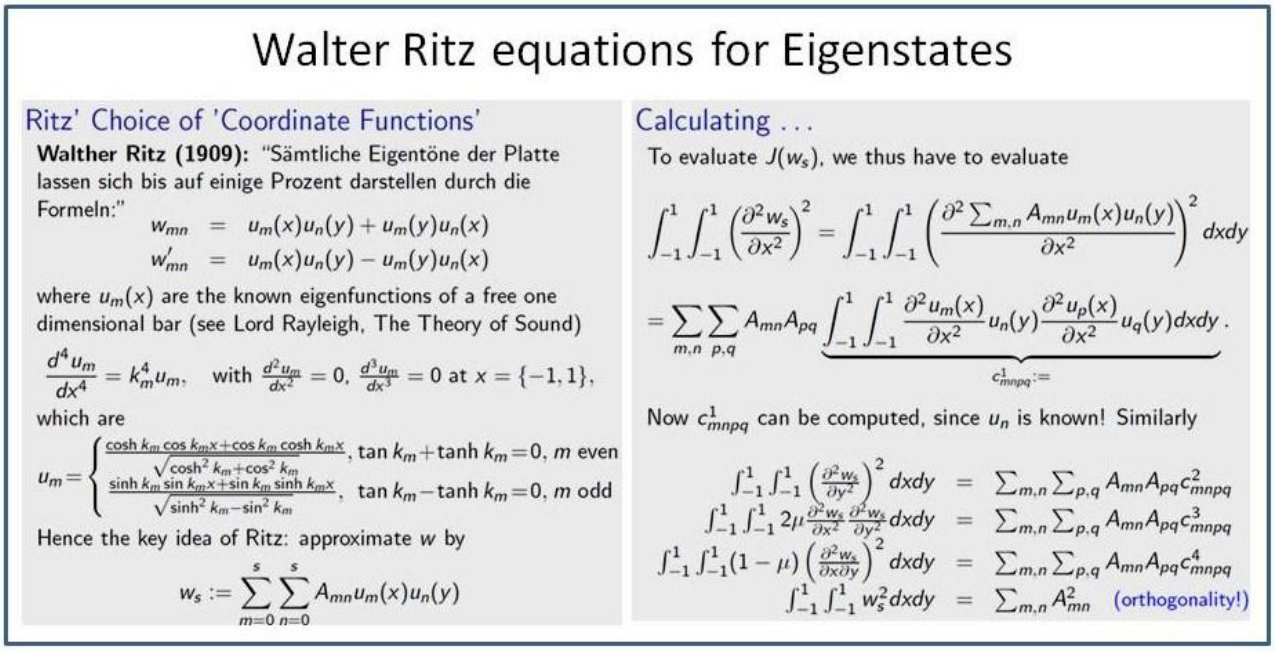

Figure 2. Part of the calculation of Ritz (ref. M.J. Gander and G. Wanner, 2010).

According to Chladni (1787), the simultaneous presence of com-possible sounds cannot be reduced in a Pythagorean way to the overtones of a fundamental: there are also "inharmonic and irrational relationships" due to the geometries of the vibrating body. By observing the pitches and patterns, while using his own developed tonometer, he concluded that 'eigenfrequencies' and eigenstates in thin square plates are related to a typical 'basic tone' G corresponding to 96 cycles per second (see appendix 1).

Still a classic way of visualizing these standing waves, is by sprinkling sand or salt on a thin horizontal plate of metal or glass and bring it into resonance now by an external resonator. The particles will move to the nodal lines, giving rise to the Chladni patterns. Nodes are points and lines along a standing wave where the wave has minimum amplitude. The opposite of a node is an anti-node, a point or line where the amplitude of the standing wave is a maximum that occur midway between the nodes. The nodes and antinodes are the basic parameters for more than 70 different 3D patterns of vibrations only at acoustic frequencies. Resonant frequencies and local amplitudes of Chladni plates can be measured by laser Doppler vibrometry or near-field acoustic holography using a spectrum analyzer (Lindemann, 2015, Figure 1C). The patterns can also be made mathematical visible by Matlab calculations (Xiao, 2010, Figure 1B).

One of the basic questions is: why are Chaldni patterns appearing at certain frequencies within a relative small frequency gap, while outside this gap the patterns disappear within a small frequency window? See for a self-explanatory demonstration on internet: As example "An Amazing Resonance Experiment" can be found on internet: https://www.youtube.com/watch?v=wvJAgrUBF4w

3. Patterns of the quantum wave information, influencing life systems

Pythagoras concluded that in music sound intervals at ratios of 2:3 are the most harmonious, while Chladni (1787) observed that various sound frequencies coexist in the vibration of a 2D body, while sound frequencies fit in overtones of a fundamental (Ullmann 1996, pp. 117–121). Ritz succeeded to develop a mathematical method in

order to compute the Chladni patterns and eigenfrequencies using the principle of energy minimization, from which his equations were derived (Ritz, 1909, Figure 2).

Geesink (2006), discovered that silicate minerals, which may act as a catalyst to synthesize RNA-like molecules, emit coherent electromagnetic patterns at discrete light, infrared and far infrared frequencies. These frequency patterns, based on quantum transitions obey to frequency ratios of 1:2, and approximate partials of 2:3 (Geesink and Meijer, 2016). Due to the fact that these minerals are a potential candidate to synthesize RNA and may have been instrumental in the initiation of first life at the edge of pre-biotic biological evolution, we decided to carry out a broad literature study to verify whether these frequencies are also found in biological cell studies. The verification was based on an extensive literature survey, comprising 175 articles from 1950 to 2015, and dealing with effects of electromagnetic radiation on in vitro and in vivo life systems (appendix 5 and 6). The study showed that typical discrete frequency bands (Figure 3) of electromagnetic waves and frequency ratios, which obey 1:2 and approximate 2:3, are responsible to stabilize cells or improve the viability of cells, whereas frequencies just in between these frequencies cause a clear destabilization (Geesink and Meijer, 2016).

Based upon these independent frequency data it was possible to compose a mathematical based algorithm (appendix 4), which touches on the knowledge of acoustics, and might describe the supposed quantum wave information of Life. It was shown that the proposed algorithm describes sequences of discrete frequencies of standing waves. The experimentally applied 97 different frequencies from a range of Hz to Peta Hz, at which the cells have been exposed, could be normalized into an algorithmic reference scale of twelve scalars from 256 till 486 Hz. It was concluded that all biological experiments showing beneficial frequencies for cells fit with 12 algorithmic basic frequencies in a small bandwidth (Figure 3).

A part of the algorithm can be mathematically described by wave equations for 2D standing known for vibrating strings, but it is more complicated to describe eigenstates of 3D standing waves, which has been solved by Ritz for eigenstates of standing waves in membranes. Another method to calculate eigenfrequencies is to consider an algorithm that mutual frequency ratios of standing waves have to interfere with the second, third and fourth harmonics of the basic frequencies and some room has to be available for a phase shift to cause circular polarization.

The algorithm has to be applicable over a broad frequency window, and over many scales/sequences and considers the knowledge of Pythagoras, that intervals: ratios of frequencies ordered at 2:3 are harmonious within one tone scale. Unlike Pythagoras we chose to apply 2:3 ratios for five intervals, and close to 2:3 for the other seven intervals, in a sequence of twelve discrete frequencies, while six frequencies in the reference scale of twelve frequencies are based upon powers of 2 and 3. The proposed scale is known as a tempered Pythagorean scale and the tempering of this scale is based upon 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 and frequencies based upon powers of 2 and 3 there is a certain harmonic relation between the basic frequencies and the overtones. Seven tones of this reference scale can be mathematically calculated by applying the diatonic tone scale proposed by Pythagoras; the remainder five intermediate tones can be calculated using the Pythagorean calculation for flats developed during the Renaissance and both described by L. Smoyer (appendix 4 and Smoyer, 2005).

It is further considered that the presence of relative phase shifts between waves are able to arrange 3D helical structures. Reasoned from one tone 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 about 1.34%. When a frequency of one cycle per second is chosen, all frequencies in all scales can be calculated. Under these conditions preferred coherent frequencies of a so called 'reference scale' can be calculated, with scalars: 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. The intervals of this reference scale can be extended to all scales, in which all lower and higher preferred frequencies are entangled by the reference scale and can be calculated by multiplying or dividing each preferred frequency of this reference scale by powers of 2.

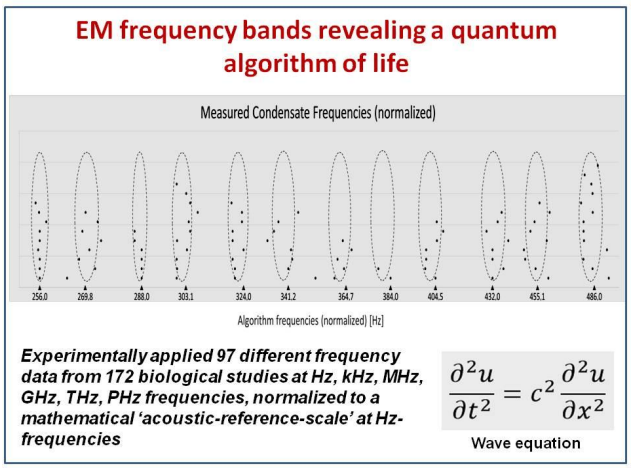

Figure 3. 12 algorithmically based, scalar, frequencies, at which biological experiments with 97 different frequencies could be positioned. The EM frequencies were experimentally applied to various in vitro and in vivo life systems, resulting in beneficial effects. All data at frequencies of Hz, kHz, MHz, GHz, THz have been normalized in a logarithmic 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.

In more simple words: We found that the algorithm is an adapted equal tempered tone scale known for a musical tone scale, in which C has been tuned at 256 Hz, and all frequencies in between frequencies with powers of 2 and 3 have been adapted to optimize the amount of harmonic relations and phase conjugation between the basic frequencies and the overtones. To realize constructive interference half of the scalars makes use of frequencies based upon integer powers of 2 and 3; the other half of the scalars is positioned in between the first scalars to approach 2:3, and one of the 12 basic scalars is positioned at a larger distance from 2:3.

It is further proposed that the algorithm of frequencies is an answer to the question of E. Schrödinger: how to solve the 'problem of small numbers': the notion that life systems contain insufficient internal information to explain their integral life complexity. It is considered that 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.

4. Data of Chladni, Ritz and calculations of Chen may confirm the "organizational principle of living systems"

To find physical evidence for this axiom it was decided to study the experiments of Chladni and the calculations of Ritz, which are also based upon small windows of preferred frequencies and also make use of the knowledge of acoustics. Therefore, we planned to fit the frequency data of Chaldni and Ritz, with our earlier published algorithmic data (Geesink and Meijer, 2016). Yet, due to the fact that it was not feasible for Chladni to measure frequencies at higher KHz (Traugott, 1836), we decided instead to analyse and evaluate more recent measurements. Five series of more recent experiments were selected, which have been carried out by independent researchers applying also thin flat square plates, but using a central mechanical oscillator or sound waves to excite the used plates, as supported by frequency measurements. Series used are of: University of Toronto, S. Morris (2012); University of Münster (2011); H. Jenny (1967, 1974) and two private scientists: Parry/Curtis. A demonstration positioned of the latter is available on you tube: *"An Amazing Resonance Experiment"*: https://www.youtube.com/watch?v=wvJAgrUBF4w (see also appendix 2, as listed below).

Subsequently, two central questions were raised: does a correlation exist between the frequency data of Chladni (calculated by W. Ritz) and these more recent measurements? And does a correlation exists between Ritz/Chladni frequencies available and the algorithmic eigenfrequencies, which were shown to positively influence the viability of cells, as surveyed in the meta-literature analysis made by us earlier? (Geesink and Meijer, 2016). Only clear patterns were employed for this comparison, leaving out those experiments that clearly showed fuzzy patterns. Such fuzzy patterns occur when the fine particles used, move from the nodal lines to apparent antinodes. Normally, the very fine particles will move to the nodal lines during the vibration experiment, in this manner giving rise to the known Chladni patterns as depicted in Figure 1. This phenomenon has also noted by Chladni himself, and was later on systematically studied by Michael Faraday, in the 1830s, through the use of lycopodium powder. Gerner has studied these type of patterns in more detail and calculated that particles are able to form, so called *inverse* Chladni patterns (Gerner, 2010). The

mechanism responsible for this is that if the vibrational acceleration of the particles on the plate remains below *g*, their movement due to the vibration is rather directed toward the antinodes.

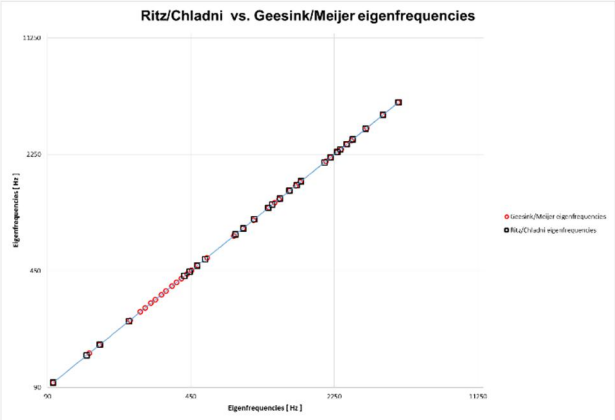

Figure 4. Comparison eigenfrequencies data of Ritz/Chladni with freq. data of the algorithm of Geesink and Meijer (90-11250 Hz).

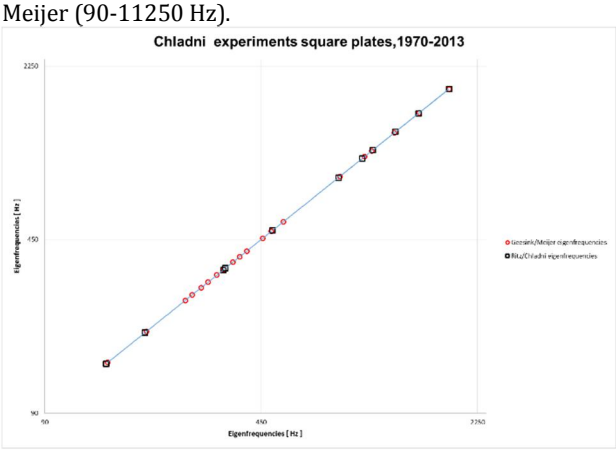

Figure 5. Comparison modern Ritz/Chladni data with freq. data of the algorithm of Geesink and Meijer (90-2250 Hz).

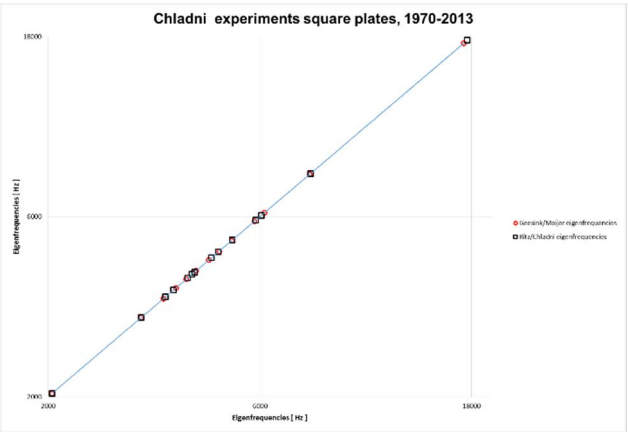

Figure 6. Comparison modern Ritz/Chladni data with freq. data of the algorithm of Geesink and Meijer (2000-18000 Hz).

The standard patterns thereby can become inverted Chladni patterns, by a specific tuning of the acceleration of the resonating plate. Gander has further confirmed that the first measured 18 frequency data of Chladni match precisely with the calculated eigenfrequencies data of Ritz. These are in the lower frequency range, probably due to the fact that Chladni was only in the position to measure the lower frequencies in between 96 Hz and 4.62 KHz (Gander, 2010).

Using the proposed algorithmic frequencies of Meijer and Geesink, 2016, it can be concluded that there is a good match with 27 randomly selected data of Ritz including 18 measured data of Chladni. The mean partial gap between de algorithmic frequencies and the Ritz/Chladni data is very close and amounts 0.91% (appendix 1 and Figure 4).

Also 26 more recent experimental Chladni type of data have been compared with our algorithmic frequency data. Inspecting Figure 5 and 6 it can be concluded that there is also a good match between the modern data and the proposed algorithmic frequencies of Meijer and Geesink. In fact, a high accuracy is shown with a mean partial gap of 0.90% (see also appendix 3).

5. Proposed torus model for quantum guided biology

Phonons, that may guide biology and interact with infrared plasma oscillations, have a nature of longitudinal standing waves, as already known for acoustic standing waves. To represent a coherence of eigenstates of standing waves, a toroidal geometry of frequency intervals is proposed. Intervals with small whole-number frequency ratios, such as the octave (2:1), the perfect 5th (3:2), the perfect 4th (4:3) and the major 3rd (5:4) have harmonic properties, and researchers have explored the possibility of a representational structure that show these harmonic relationships. Repeating ascending octaves suggest that these harmonic relationships are helical, which is why researchers have independently investigated pitch spirals or harmonic helixes. We propose that there is an analogy in between the scalars of a quantum field, BEC's and the science of acoustics and more precisely the knowledge of the Tonnetz.

The Tonnetz has been re-used in different ways by neo-Riemannian theorists: Drobisch (1855), Lewin (1978), Shepard (1982), Chew (2000), and Lerdahl (2001) to describe the relationships between major and minor triads. The neo-Riemannian Tonnetz (shown in Figure

7) is a planar array of pitches along three axes, corresponding to three consonant intervals applied for sound. Related pitches are placed near one another, and less closely related pitches placed farther apart. Major and minor triads are represented by triangles which tile the plane of the Tonnetz. The triangular lattices present identical musical constructs such as chords regardless the beginning pitch and show hexagonal isomorphic geometries. Edge-adjacent triads share two common pitches, and so the principal transformations are expressed as a minimal motion of the Tonnetz, which wraps the planar graph into a torus (Figure 7) and different helix angles have been proposed (Shepard; 1982).

Mathematicians have calculated the eigenstates and frequencies of tori. Faure considered a linear hyperbolic map, which generates a dynamical system on the torus. The model describes the phases and eigenfrequencies that govern interference phenomena, which are characteristic of wave dynamics and quantum dynamics. The difference from quantum dynamics is that there is no uncertainty principle in prequantum dynamics, and that the hyperbolicity hypothesis on the dynamics implies that the prequantum wave functions escape towards finer and finer scales (Faure, 2007). The behavior of coherent states on a torus has been studied for various types of localized states, similar to the coherent states of a harmonic oscillator, which are maximally localized in a phase space (Fremling, 2013). The classification of closed lines on the torus corresponds to a discrete set of energy levels, mirroring the analogous quantization of energy levels of an atom (Jantzen, 2010).

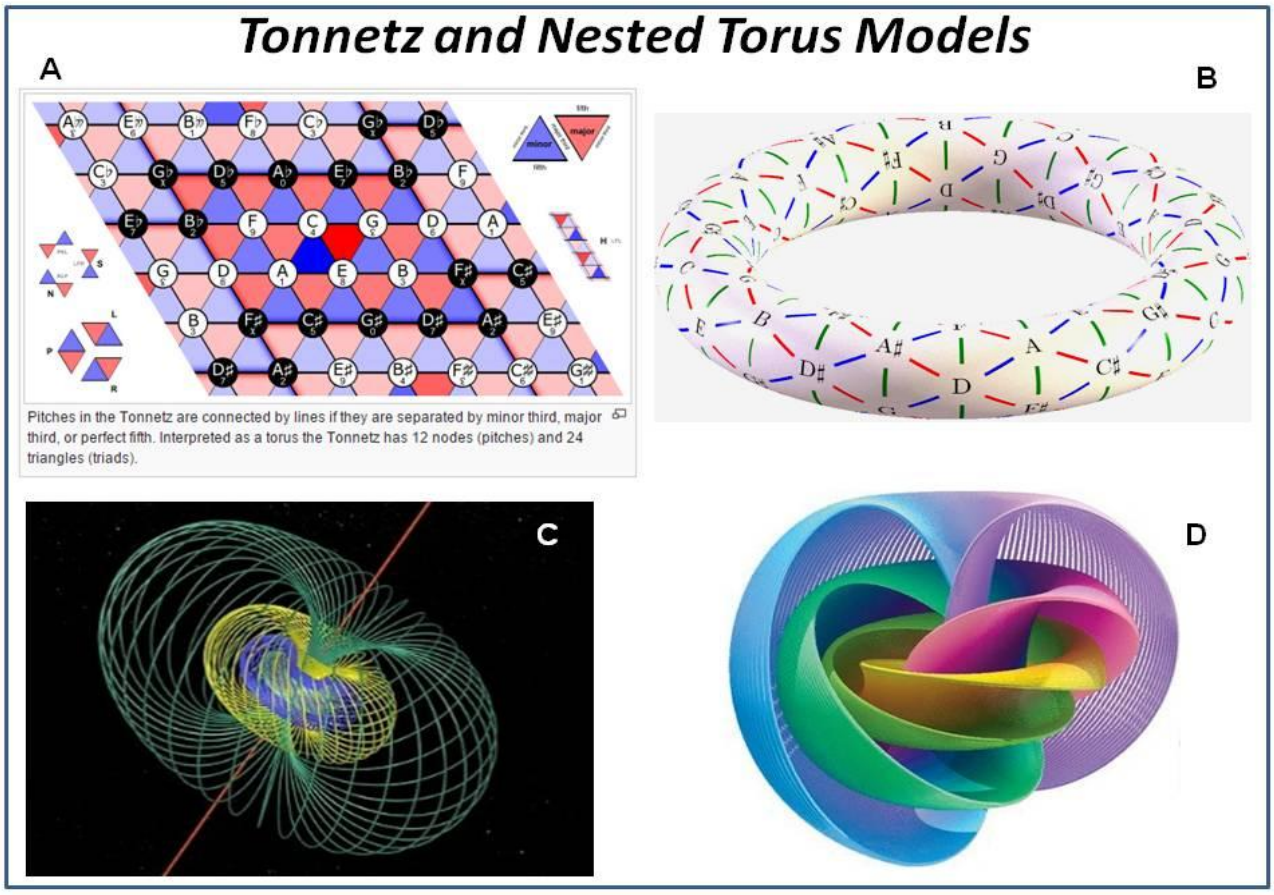

Figure 7. A: Neo-Riemannian Tonnetz. Triangular net with keys as vertices and triads as triangles. The triangular net forms a torus, and has 12 vertices and 24 triangles. Major triads are red, minor triads are blue. Thin lines stand for minor thirds, thicker lines for major thirds. The even thicker horizontal lines stand for fifths. B: View of the neo-Riemannian Tonnetz torus. Triangular net with keys as vertices and triads as triangles: green minor third, red major third, blue perfect fifth. C: Proposed torus with nested tori, D: nested representation of Hopf vibration as derived from torus geometry.

Ritz and Chaldni solved the problem how to generate eigenstate wave functions and eigenfrequencies for 2D flat squares and circular plates. The relationship between the

eigenfrequencies and the numbers of nodal lines and nodal circles proposed by Chladni for the vibration of flat circular plates, can be generalized for 3D shapes, and has been verified for acoustic patterns of church bells (Rossing and Perrin, 1985, 1987). These bells typically have the form of a cup-shaped resonator with a flared thickened rim. Partials from third, quint and octave at frequencies an octave above the strike pitch of the bell are harmonically correlated with the nominal frequency of the bell (Hibbert, 2014).

Chen/Coleman/Zhou have extended the wave method of Keller and Rubinow to the biharmonic eigenvalue problem with rectangular or circular geometry and clamped boundary conditions. This suggests that plate and membrane should have very similar vibration behaviour and leads to the assumption that the covering space of a rectangular plate is still a torus (Chen, 1991). By adding several waves on the boundary, approximated eigenfrequency equations can be derived.

It is already known that localized states on a torus have many properties in common with the coherent states on a square plane or on a sphere, or in a cup-shaped resonator. The current Tonnetz model is able to order three basic intervals of musical scales in a 3D toroidal space and it is proposed to extend these three basic intervals positioned on the torus to twelve basic intervals, described by the algorithm.

These intervals of the algorithm are just and closely approaching: 1:2, 2:3, 3:4, 3:5, 4:5, 5:6, 5:8, 5:9, 8:9, 8:15, 24:25, 32:45 and each sequence has its own helical path on the torus surface, with a characteristic angle. At this manner all sequences of eigenfrequencies described by the algorithm are located at the different torus surfaces from the lowest possible frequencies: less than 1 Hertz, till the highest frequencies: at far infrared frequencies. All sequences are nested (see Figure 7 C) on the surfaces of the tori, according to the principle of the Matryoshka Nesting Dolls. In order to realize coherency of waves it is proposed that all nested tori converge to a central point. At this manner the lowest frequencies are positioned outside the torus, and the higher frequencies inside the torus space: at this manner a centralized helical form of influx and outflux is achieved. In the center point of the torus all waves converge and diverge at typical infrared frequencies sequences and octave frequencies thereof: 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.

These frequency patterns provide an intrinsic longitudinal/acoustic like steering mechanism that may pervade all complex and intelligent organic life in our galaxy, from micro to macro scales (for the latter see Grandpierre, 2016). Görnitz (2016), pointed out that we know very little of the fabric of reality going from the size of the electron down to the Planck scale and that it is a misunderstanding that smaller structures will also become more simple. In contrast, an informational quantic pre-structure is required (called protyposis) that can transform or instruct matter/energy on the stage of life to meaningful information. The connective principle of this integral information domain has been described in both holographic and fractal characteristics, covering the entire cyclic cosmos down to the Planck scale (Meijer, 2015). To model such a fractal condition in geometric terms, we prefer to postulate a *nested* torus modality, indicating the self-similarity and recursive elements in the framework of a scale relativity space-time theory (see for an introduction Wikipedia/Scale relativity), and further highlighted in toroidal terms in the fractal-holographic universe (Bjerve, 2016). It is of interest that both the metric of brain waves (Weiss and Weiss, 2003) and the basic wave energy relations at the Planck scale have been described by golden mean ratio-like clock cycles. This aspect may also be relevant for an integral approach of brain function: Smythies (2015), described protein vibrations in information processing in the brain as a threefold nested Russian doll, while Meijer, 2014, alluded to a nested and bi-cyclic neural workspace in the concept of an extended brain function that integrates micro and macro scale imbedding of (self)- consciousness. Biological system can be seen as a nested ensemble of cavities within cavities of different sizes (organs, tissues, cells, organelles, through well-defined sizes in molecules), thereby having a plurality of internal configurations, that can become spontaneously coherent once a critical density is overcome. This implies that within the coherent domain (CD), a coherent plasma of quasi-free electrons is present. This plasma is able to give rise to so called coherent “cold” vortices that in fact underlie the fractal nature of living organism, in which fractals are just the consequence of the sequence of nested coherent dynamics. Water

CD's are able to release electrons, either by quantum tunneling or by mild external excitations. A difference of electric potential in the order of several tens of millivolts has been estimated to be present across the interface at the boundary of water CD's (Del Giudici *et al.,* 2010) and the long lifetime of the single excitations enables a range of excitations that produce a sharp decrease of entropy. This may also be instrumental in the transduction of physical information and even exchange of complex life information between coherent water domains and DNA (Montagnier *et al.,* 2014).

The fabric of reality and life therein may therefore be perceived as a musical symphony and in this respect it is of interest to establish how music is represented in tonal geometry in our brain. Music is found in all cultures and has a remarkable diversity of forms. Cognitive scientists have discovered highly specific and detailed knowledge of a sort of musical structure even in individuals without extensive musical training. Brain imaging has proved valuable for investigating the neural basis of a variety of cognitive functions, including how the brain processes music (Janata *et al.,* 2002). They report that abstract patterns of Western tonal musical structure are mirrored in patterns of brain activity in human subjects, using functional magnetic resonance imaging. The investigators found that the auditory cortex as well as a number of other brain areas were activated in their subjects as they undertook the musical perception tasks. It should be stressed that any electromagnetic radiation frequency exhibit a concomitant sound modality. Interestingly NASA recently reported the typical sound related to our earth magnetic field (Gonzales, 2012).

6. The potential mechanisms for quantum wave effects on life systems, with special reference to toroidal information processing

The single torus can be considered basically as a surface of revolution, generated by revolving a circle in a three-dimensional space about an axis coplanar with the circle, in this manner in fact being a product of two circles. As treated in our previous report (Geesink and Meijer, 2016), 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 (Figure 7).

The torus is usually seen as the fundamental form of balanced energy flow found in sustainable systems *at all scales*. The higher dimensional and super-symmetric aspect of the double vortex torus, provides the following desired properties: compatibility with acoustic and electromagnetic modalities; housing of balanced bi-spiral energy flow with a rotational character; micro- to macro dimensions and fractality, in particular in nested tori; maintenance of balance of unity/polarity; modeling of density gradients; recursive/repeating aspects; can express geometric relations; has distinct self-referential properties; provides openness to 4D geometry; mimics compression/expression of information; introduces relaxation/contraction aspect in movement; enables definition of eigenstates, standing waves/scalars; suitable for geometric modeling of elementary particles and particle/antiparticle symmetry; invites potential superposition as well as entanglement and phase-conjugation elements; and provides protected inside-out system dynamics. Furthermore, the torus shape exhibits a symmetry that keeps the amount of magnetic flux, that can potentially escape, to a minimum and exhibits phase transition to spontaneously long-range of microscopic magnetic toroidal moments, in addition to electric polarization. Finally, the torus geometry offers an intrinsic holistic/metaphysical framework, since it can operate a manifest state within a unified field.

The torus has also been claimed to represent 4D geometry, due to the functional coupling and intrinsic unity of its two poles. Bermanseder, 2011 made clear that the toroidal 3-D structure allows communication with a 4th spatial dimension because of the multi-connectedness of the toroidal geometry. In contrast to a 3D sphere, the surface of a 4D vortex, houses two spirals towards its centre where they meet, thereby creating a standing wave/stationary state of oscillation, which, at least in our 3D space, manifests itself like an alternate explosion and implosion. In the inner part of the torus, the overall positive curvature of the 3-D torus sphere is balanced by the negative curvature known from the 4-D AdS space. A stereographic projection of a Clifford torus in four dimensions shows a rotation of the 3-D torus through the xz-plane. The 4-D modality thus is

attained by an extra rotation: while a 3D-torus can be envisioned as a cycling circle, a 4-D structure introduces a third cyclic element that rotates the torus inside out as initiated by the internal negative curvature plane (Figure 8, 10 and 12).

By following electromagnetic energy flux out of the central hole, via some projected trajectory down one spherical halve, the final destination is always the same central hole. However, one is now in an identical "anti-universe" space. In the particular opposite part of the central pole, the photon/phonon wave enters the domain of 3-D-to-4D oscillation, in which it undergoes constructive wave interference and in finally returns in modified form to its geometric origin (Figure 8 A and D). This infinite type of closed rotation enables information control and protection against information loss by de-coherence modalities.

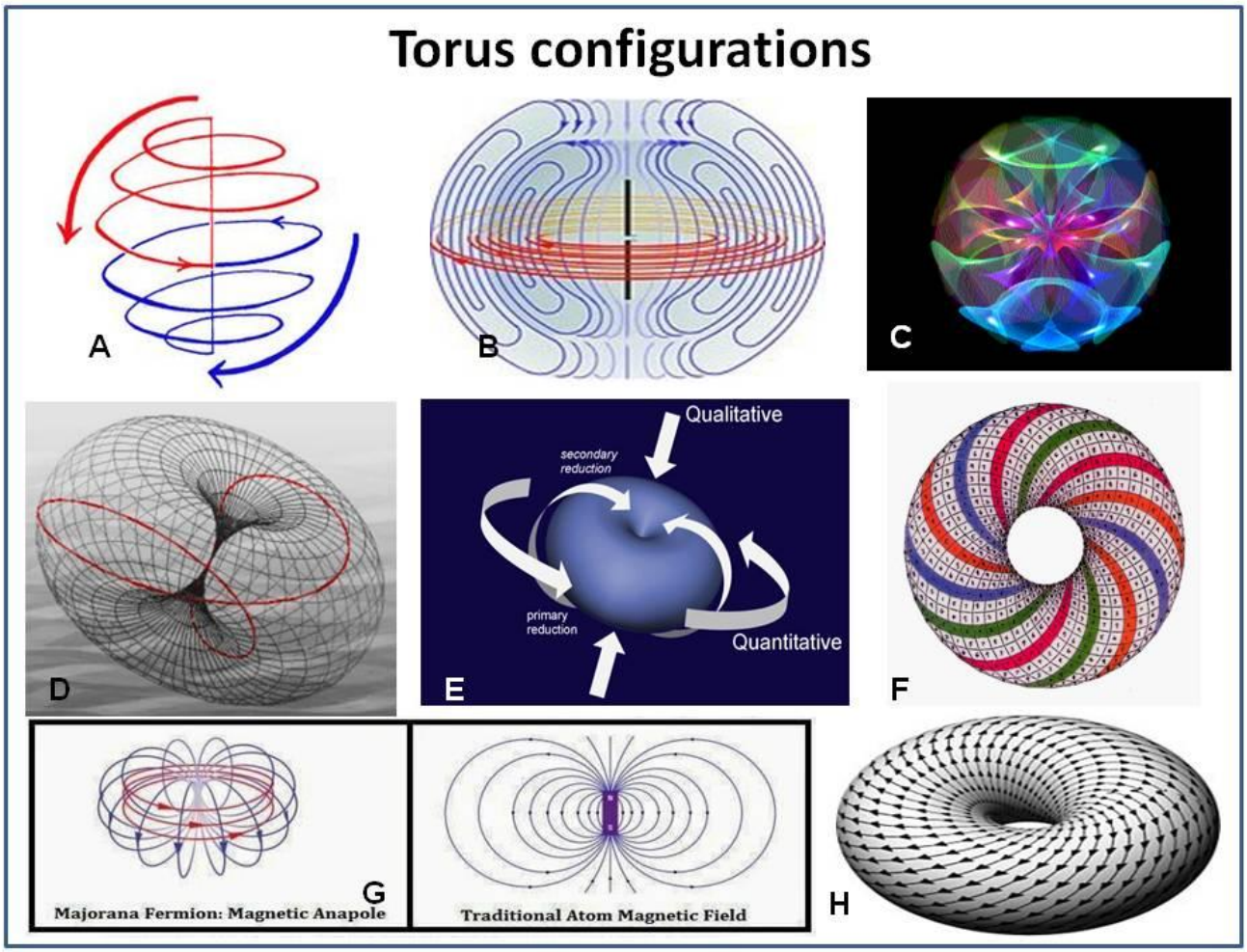

Figure 8. Various concepts of torus configurations: A: Double spiral, B: orthogonal double circle, C: Contracting and relaxing toroidal movement, D: Trajectory on torus surface, E: Orthogonal circuitry indicating qualitative and quantitative aspects, F: Nested torus model, G: Magnetic anapole, H: Tonetz torus.

In this manner, toroidal flow patterns set up vibrations and resonance, that create standing waves where opposing frequencies interact intensively in the eye of the torus. The 4-D geometry also explains the well known aspect of self-interference as have been shown for photons, electrons and neutrons (Yepez, 2008). A progression of toroidal flow through the different classes of tori may define the evolutionary progression from consciousness to matter/energy in the universe at micro- to macro scale: the ring torus equating to black holes, the horn torus to active galactic nuclei and the spindle torus to material forms from planets to Earth-based lifeforms. The topology of the spindle torus may even give us the underlying explanation for the left-right cross-over between the two hemispheres of the brain and the

distributed nervous system of the body in the nervous system. Interestingly, one superstring model, called the type IIa theory, postulates that the 6 extra space dimensions are compactified around a 6-dimensional torus (or tori).

Wheeler and Feynman (1945) have modeled the electron as spherical inward and outward electromagnetic waves. Besides electrons, also photons are considered to have toroïdal geometries (Williamson, 1997; Yepez, 2004). Various modalities of (nested) tori have been applied in geometric aspects of string theories (Green, 1986). These include, so called, twistors, proposed by Penrose as building blocks of spacetime, exhibiting a nested and vibrational structure (Hopf vibration, Figure 7D). Twistors posses aspects of holonomy, entanglement and enable an approach to quatum gravity without the need for the many extra dimensions as usually required in string theory (Witten, 2003). At the ultra-micro (Planck) scale, micro-wormholes have been pictured as vortices, forming the very matrix of quantum foam and branes (Penrose, 2014). The central spiral vortex is used for the topological description of the spin phenomenon in fermions, and entanglement is applied to enable non-local quantum information exchange (Wolff, 1995). In the Standard Model point-like particles such as electrons have an intrinsic spin and momentum, and may interact with a diverging electromagnetic field connected with a vacuum, and coupled with information storage (Amoroso, 2009). Also informational qubits have been modeled with toroidal geometry (Ozols, 2007), while recently, so called, super dense teleportation of entangled photons was described using a 3D-hyper torus model (Graham *et al.,* 2014). On a cosmological scale the torus may display expanding and contracting modalities at the same time and was thought to represent a 4+1-dimensional space-time manifold for describing black holes and wormholes (Tegmark *et al.,* 2003). The toroidal moments created, imply a multi-pole expansion of electromagnetic fields. Electric dipoles can be understood as separate charges and magnetic dipoles as circular currents. Dipole moments are vectors with potential differing symmetries under spatial diversion and time reversal. Polar magnetic toroidal dipoles are called anapoles and are candidate for describing cold dark matter (Dupays *et al.,* 2013).

The torus geometry has also been used to lay the basis for a supposed harmonically guided evolution (Merrick, 2010, Figure 9) in which atomic resonance creates organic shapes and geometric folding of carbon containing molecules. This in addition to lattice type of organization of dipole water molecules, together forming life harmonic 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-existing universal law intrinsic to nature, (Tenen, 2002) and conceptualized as a toroidal alternative to random self-organization (Haramein, 2013; Bjerve 2016).

Toroidal information integration and processing, 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. From this perspective, one may perceive reality as a vast interlacing network of discrete fields of toroidal oscillations that interact with the vibrational fields of life systems, a communication process in which photons of various energy content and solitons may play an essential role. This dynamic interactive system may be present in all living cells, in which the cytoplasm water molecules form geometric self-assemblies, also at the surface (hydration shell) of vibrational (glyco)-proteins that together may form a sort of ordered quasicrystal structures, that can be reduced to a finite number of repeating units (Chaplin, 2000; Johnson, 2009). Such a crystalline lattice may enable resonance with an all-pervasive energy field, on a micro-scale resembling the framework of a quantum lattice theory.

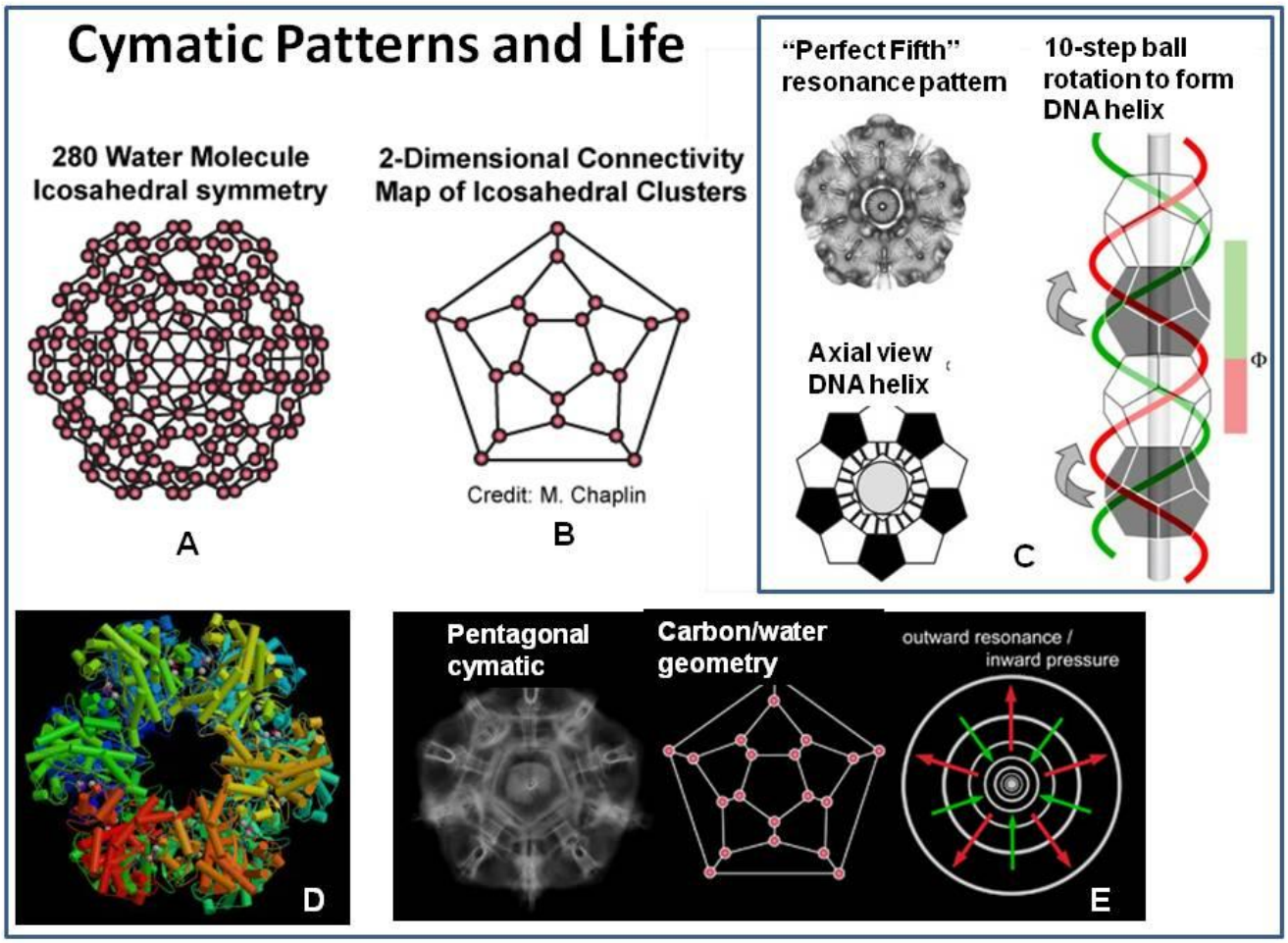

Figure 9. Cymatic patterns and Life structures: A and B: Isohedral water molecule arrangements, C: cymatic resonance of DNA double helix, D: Schematic representation of a membrane channel protein, E: pentagonal cymatic carbon/water resonance.

7. Electromagnetic eigenfrequencies in relation to quantum coherence in life systems

In quantum field theory, the fields can be described by quantum operators in a Hilbert space. The mathematical concept of a Hilbert space, named after David Hilbert, generalizes the notion of Euclidean space. It extends the methods of vector algebra and calculus from the two-dimensional Euclidean plane and three-dimensional space to spaces with any finite or infinite number of dimensions. Canonical quantization is a procedure for quantizing a classical theory, while attempting to preserve the formal structure, such as symmetries to the greatest extent possible and was introduced by Paul Dirac in 1926. A construction of a quantum scalar field can be described through a canonical quantization, which makes use of functions of frequencies among fields and represents a number of quantum harmonic oscillators. It is known that such mathematical expressions, governing the behaviour of fields, produce various divergent (infinite) expressions. The "divergence problem" has been calculated in the case of quantum electrodynamics during the late 1940s and early 1950s by Bethe, Tomonaga, Schwinger, Feynman, Dyson and Nelson. The divergence of a vector field can be represented by the geometry of a 3D vector field (Figure 10a), in which the flow is exploding outward from an origin, a phenomenon that also be conceptualized in vortex and toroïdal models (see Figure 10b), and may provide the basis for understanding the dynamics of solitons and phonons (Munos Matteo, 2014, 2015).

We, previously, found support for the hypothesis of H. Fröhlich, that a driven set of oscillators condenses in a broad energy range, and may activate a vibrational mode in cells of life organisms at room temperature. This idea was based upon the discovery of life sustaining frequencies, as extracted from 175 biological

articles from 1950 to 2015, dealing with effects of electromagnetic radiation on in vitro and in vivo life systems, and able to describe by an algorithm of discrete coherent frequencies of standing waves (Meijer and Geesink, 2016). Interestingly, our concept is in line with the above mentioned investigations of Munoz Mateo, in which solitons of BECs are composed of intersecting vortex rings, geometrical figures, and lines in a channeled superfluid (Munoz Mateo, 2014, 2015). Here we clearly observe an analogy to Chladni's figures of membrane vibrations.

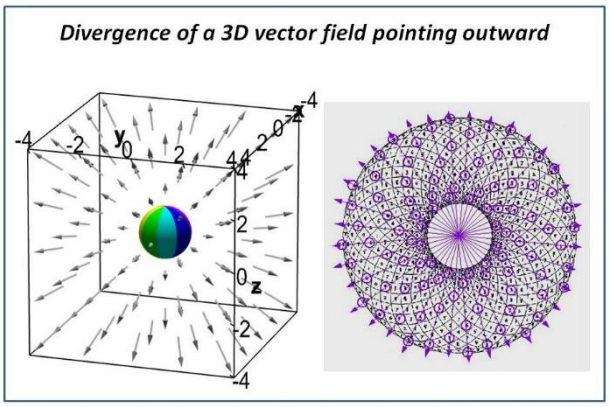

Figure 10. Divergence of a 3D vector field pointing outward.

In the present paper we therefore propose a mechanism for quantum wave effects on life systems, of which the information is processed by a toroidal quantum field at typical scalars and related to Fröhlich-Bose-Einstein condensates. The toroidal field is supposed to be positioned in between 3-D and 4-D, of which the eigenfrequencies at the interface can be derived from an algorithm. The development of quantum theory on a torus, (of which the exact frequencies, to date, remain to be established), has been started in 1920 with the attempts of Nordström, Kaluza and Klein to define a fourth spatial dimension with a finite size, that was proposed to take the form of a torus. The model of Nelson (1986) described a system of quantum particles, which move in the 3-dimensional Euclidean space under the influence of an external potential, and which interacts with a massless scalar Bose field. The massless scalar Bose field is a quantized scalar field with self-interacting scalars and made of massless bosons.

Bose Einstein Condensates (BECs) are studied in order to describe a state of matter in which separate atoms or subatomic particles, cooled to near absolute zero (zero degrees Kelvin, – 273.15 °C), coalesce into a single quantum mechanical state. This form of matter was predicted in 1924 by Albert Einstein on the basis of the quantum formulations of the physicist Satyendra Nath Bose. Bose considered how groups of photons behave, and although Bose and Einstein stated their theory in terms of photons, they disappear during cooling toward absolute zero. As they lose temperature photons change their light frequency until finally they leave the visible spectrum and become far infrared photons.

Waves can be experimentally generated in BECs in dark and bright solitons, which are wave packets, which share generic features like form-stability, vortices and lattice patterns. Instabilities in BEC's can be prevented by using regulating the trapping conditions, and combinations of trapping frequencies in electromagnetic fields at low frequencies, infrared, green laser light and magnetic confinement. This in order to hold the subatomic particles/waves in place without a material container, at which coherent stable structures of longitudinal waves are realized. BEC's are in the class of longitudinally expanding systems, encompassing strongly correlated plasma's and N-component self-interacting scalars, which occur in the far infrared regime. Bosons including photons have a quantum spin, which is a nonnegative integer (0, 1, 2, …), while fermions including electrons have a spin, which is an odd half integer (1/2, 3/2, …). BEC's can be cast as a vertex-resumed kinetic theory and as a non-relativistic system, reminiscent of superfluids in 3+1-dimensions. The formation of the condensate can be described by a power law, using powers of 2/3 and -2/3 (Berges, 2015).

Open boson systems may also have relevance in the functioning of information-processing in biological and condensed matter systems. The so-called Fröhlich–Bose–Einstein condensation is a self-organizing dissipative structure, a phenomenon working in biological processes and present in systems of boson-like *quasi-particles (*also called phonons*)* in condensed inorganic matter (Vasconcellos and Luzzi, 2012). 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, 1988). According to the Fröhlich hypothesis, large numbers of quanta condense into a single state Bose condensate, which constitute a physical and non-thermal interaction between cells at room temperature (Fröhlich, 1968).

8. Phonon guided biology through toroidal coupling: the role of far infrared quantum states and implication for brain function and consciousness

As a follow up of our earlier study on a quantum algorithm for life (Geesink and Meijer, 2016), we propose in the present study to consider a phonon guided mechanism, operating as a bi-cyclic flux pattern in a 4+1 dimension geometry, that can be modeled by a toroïdal flux of quantum information at the various holo-fractal scales in nature, including brain and conscious perception. Torus geometry, as a flow process treated in the previous section, exhibits a set of characteristics that evolution biologist, Sahtouris (2000) has identified as features and principles of living systems. 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. Essential is the concept that nature inherently includes feedback loops, as a self-reflexive process, by which the system learns from its environment, adjusts to maintain balance and well being and subsequently communicates new patterns, that exhibit these adjustments, back to its surroundings in order to inform the living system as a whole. According to a fractal-holographic view the same patterns are repeated at each scale and the whole is present everywhere at all times, in a unified geometric field. Toroidal concepts also allow a conceptual approach of brain function using the geometric *relation between con*cepts and, for instance tone induced ordering of percepts, instead of using neuronal or symbolic networks.

Vattay, Kauffman and Niiranen gave an explanation on how biological systems can stay quantum coherent for a long time at room temperature, being one of the fundamental puzzles of quantum biology. They show that systems, with the right level of complexity between chaos and regularity, can increase their coherence time by orders of magnitude by making use of new information. Systems near critical quantum chaos (Metal-Insulator Transitions, MIT), which are related to coherent oscillations of condensed matter, can have long coherence times and coherent transport at the same time. Photons are not just under the influence of environmental decoherence due to random noise, but also influenced by waves of the incoming photons. The photons are absorbed by the chromophores which initiates an exciton on one of the chromophores in an initial state which is concentrated on the selected chromophore. By tuning the timings of re-coherence events and the coherence time during decoherence via tuning the system on the chaos-regularity axis can be kept in high level of purity. This makes it possible to create new quantum devices working at room temperature capable of nearly frictionless quantum transport of energy and information (Vattay *et al.,* 2014). Robert presented a broad perspective on biological organization and pictured how quantum-like dynamics and coherence might shape the very fabric from which complex biological systems are organized. The implications of large-scale coherence in biological systems and possible links to quantum theory are only beginning to be explored. Whether quantum-like coherent phenomena are relevant, or even possible at all at the high temperatures of biological systems, remains unsettled. Regardless of its exact nature, a unique form of coherence seems apparent at multiple scales in biology and its better characterization may have broad consequences for the understanding of living organisms as complex systems (Robert, 2012).

In biology, the discovery of the genetic code and the 'central dogma' statement of molecular biology, that information flows from DNA to proteins, have led to the ideas that information and in particular the intrinsic ability to process information in living entities is seen as fundamental. This also led to the postulate that the integration of active information explains the phenomenon of consciousness in nature (Tononi, 2015). The origination of first life was also seen as a collection of life sustaining information from the environment, and this concept is often supported by assumptions on self-aggregation and emergence to “explain” the complexity of life,

(see Davies, 2004 a b, Melkikh, 2014). However these well known concepts may overlook an aspect in the origination and sustaining of life systems, namely that during the entire timeframe of biological evolution up to the present time, pre-biotic and life-systems were exposed to long distance force fields such as gravity/inertia, electromagnetism, coherent quantum states of minerals and zero-point energy, related to the intrinsic earth electromagnetic field, as well as related to the location of our planet in our solar system and milky way galaxy. In this respect life on earth was not incubated in an empty vacuum but rather immersed in a versatile and active force field, composed of natural coherent quantum states and electromagnetic fields. Cosmic space, including the earth atmosphere permanently contains quantum states of ion water clathrates, Rydberg matter and micro-silicate particles both able to emit quantum resonances among others at far infrared. A-priory information for the organizational aspects of life (Melkikh, 2014) therefore should have been omni-present, if not primordial, and can be implicitly envisioned in the framework of present models of a circular universe (Steinhardt and Turok, 2007; Penrose, 2014).

Light in condensed matter in the upper atmosphere is probably the origin of homochirality, related to circularly polarized light from Rydberg matter (Holmlid, 2012). Clouds of the condensed excited Rydberg matter (RM) exist in the atmosphere of Earth and the circular Rydberg electrons in the magnetic field in the RM may be chiral scatterers. It has been shown in experiments with RM that linearly polarized visible light, infrared and far infrared scattered from an RM layer is transformed to circularly polarized light. Amino acids and other chiral molecules will experience an interaction with this light field and the interaction will vary with the stereogenic conformation of the molecules and in all probability promote the survival of one enantiomer.

We propose that quantum oscillations, among others at far-infrared (Terahertz) frequencies, transferred by phonons is co-instrumental in the fractal and geometric organization of biomolecules. Oscillations of quantum oscillations are embedded in electromagnetic waves at much lower and higher frequencies and are emitted by water clathrates, ions and minerals. Water clathrates, minerals and gases in the higher atmosphere and top layer of earth have both their specific ordering patterns and frequencies at far infrared. Also orderings patterns and conformational states of biomolecules are at typical far infrared patterns. Vibration patterns of developing plant organs have been calculated by A. M. Pietak, considering the frequency-dependent passive electromagnetic properties of water and biological tissues in the microwave-terahertz range using a finite element analysis model to determine resonant EM modes for models with similar geometric and electrical parameters (Pietak, 2012).

Neurons are able to directly sense THz resonances: responses of cortical slices of the adrenal gland are at terahertz frequencies and at power densities of 0.3-0.6 microWatt/cm^2 (Pikov and Siegel, 2010). Microtubules present in our brains have specific resonance frequencies in the range from kHz to THz (Sahu and Bandyopadhyay, 2014). In the context of the hot, wet and noisy living brain, a strategy seems adopted that neurobiological mechanisms constrain the evolution of phonon patterns of ionic systems as well as the related distribution of electronic states in the ions, to create quantum-like coherent macro-states (Pereira, 2007). Low-frequency phonons in proteins at far infrared can be measured in proteins as was originally proposed by Chou and Chen, 1985, in order to solve a “free-energy deficit” problem in protein binding. Subsequently, the aforementioned low-frequency modes can be observed by Raman spectroscopy for a number of protein molecules and different types of DNA.

Our proposal of selective EM frequency bands and quantum states of matter, of which the corresponding resonance modalities show sustaining properties interacting with intra-molecular vibrational of living cells, invites the question in what manner the particular wave information could be transmitted and exposed to the life systems, so that a crucial stabilizing effect is attained. In principal a number of potential physical mechanisms may play a role:

-Operation of, so called, open Boson systems, interacting through lattice vibrations and under the action of RF-electromagnetic fields (Vasconcellos and Luzzi, 2012)

-Phase conjugation by wave information interference (Mitchell and Staretz, 2011)

-Quantum information by superposition, entanglement and/or tunneling (Huelga and Plenio, 2013)

-The principle of"Metal-Insulator Transitions" of biologic molecules, capable of nearly frictionless quantum transport of energy and information (Vattay, Kauffman and Niiranen, 2014)

-EM-induced configuration of the memory-encoded information from life tissue (Rouleau *et al.,* 2014)

-Geometrically imposed ordering of cell structures and metabolic processes (Merrick, 2010; Tenen, 2002)

-Holographic and fractal information processing towards attractor states (Keppler, 2012, 2013)

-Conversion of virtual particles/diluted plasma of the ZPE field by Casimir like reduction in compacted space cavities (Dupay *et al.,* 2013; Hameroff, 2015; Persinger, 2010)

-Nested toroidal phonon/photon/electron coupling into scalar wave information and transmitted by a dilute plasma (this paper)

On the basis of our previous (Geesink, 2013; Meijer, 2014; Geesink and Meijer, 2016), present work and cited references, we postulate in this section that discrete quantum resonances including coherent far-infrared resonances, induced by a far distance field, are co-instrumental for the ordering of water molecules and associated biomolecules and thereby support the conformational states of cells, including chirality. Important assemblies of cells steered by external quantum resonances and EM fields are present in neurons, glia cells, glands, microtubuli and are related to our brain as well as our consciousness.

The role of phonons, solitons, photons and electrons and consciousness

Particles found in biological processes include photons, electrons, protons, elementary ions, inorganic radicals, organic radicals, molecules, and molecular aggregates. Frequency, wave vector, polarization and phase are degrees of freedom that are often used to describe a photonic system. In the last few years, *topology*, a property of photonic materials that relates to the global structure of their frequency dispersions, has been emerging as another indispensable ingredient, opening a path forward to the discovery of fundamentally new states of photonic fluxes. The photon, as a mobile bit of quantum information, is also regarded as 'qubit'. In living systems, the excitation of electrons by photons and the subsequent conversion of that excitation into the bond energy is called photosynthesis and is a basic builder of biological structures. The reversal of this process is called bioluminescence. This phenomenon is the transfer of energy from a bond to an excited electron, resulting in the emission of a photon. Radiated photons are one type of electromagnetic signal. The photonic flux process may or may not only manipulate and guide photons but also convert photons into electrons and process the electrical signal.

Solitons are regarded as a self-reinforcing solitary waves (a wave packet or pulse) that maintain their shape while they propagate at a constant velocity. Devyatkov has described these solitons in relation to the mechanisms of the interaction of weak electromagnetic fields with the information structures within a cell, like the nucleic acids, proteins and membranes. He proposed that biological effects caused by waves are dependent on: wavelength, modulations, dose, exposure time, coherence and magnetic field (Devyatkov, 1974, 1991). Several ways of excitation of levels of collective modes have been considered and a concept has been proposed that solitons suppress anharmonicity (the deviation of a system from being a harmonic oscillator) by the excitation of high quantum levels, which facilitates crossing of a potential barrier and transfer of a molecule to a new conformational state. The energy spectrum of an electron moving in a periodical potential of a crystal lattice consists of allowed and forbidden bands and is known as the Bloch spectrum. An electron with energy inside an allowed band moves as a free electron but has an effective mass that differs from the electron mass in vacuum. However, a crystal lattice is deformable and displacements of atoms (ions) from their equilibrium positions are described in terms of phonons. Electrons interact with these displacements, and this interaction is known as electron-phonon coupling. Such an electron with the accompanying deformation moves freely across the crystal, but with increased effective mass.

Pekar (1963) proposed for this charge carrier the term *polaron*. The polaron, is

a *fermionic* quasiparticle, in contrast to a *polariton, which is a bosonic* quasiparticle analogous to a hybridized state between a photon and an phonon. In this context the Davydov soliton corresponds to a *polaron* that is (i) *large* so the continuum limit approximation is justified, (ii) *acoustic* because the self-localization arises from interactions with acoustic modes of the lattice, and (iii) *weakly coupled* because the anharmonic energy is small compared with the phonon bandwidth. Optical phonons correspond to a mode of vibration where positive and negative ions at adjacent lattice sites swing coherently, creating a time-varying electrical dipole moment and therefore are called infrared active (Figure 11). A recent study of Matsuura and Wasaki, 2014, describes a quantum current model in nerve axons on the basis of traveling polaritons along the axon, in which these bare particles associate with water molecule dipoles into quasi particles that participate in the axonal depolarization/repolarization process (Figure 11B).

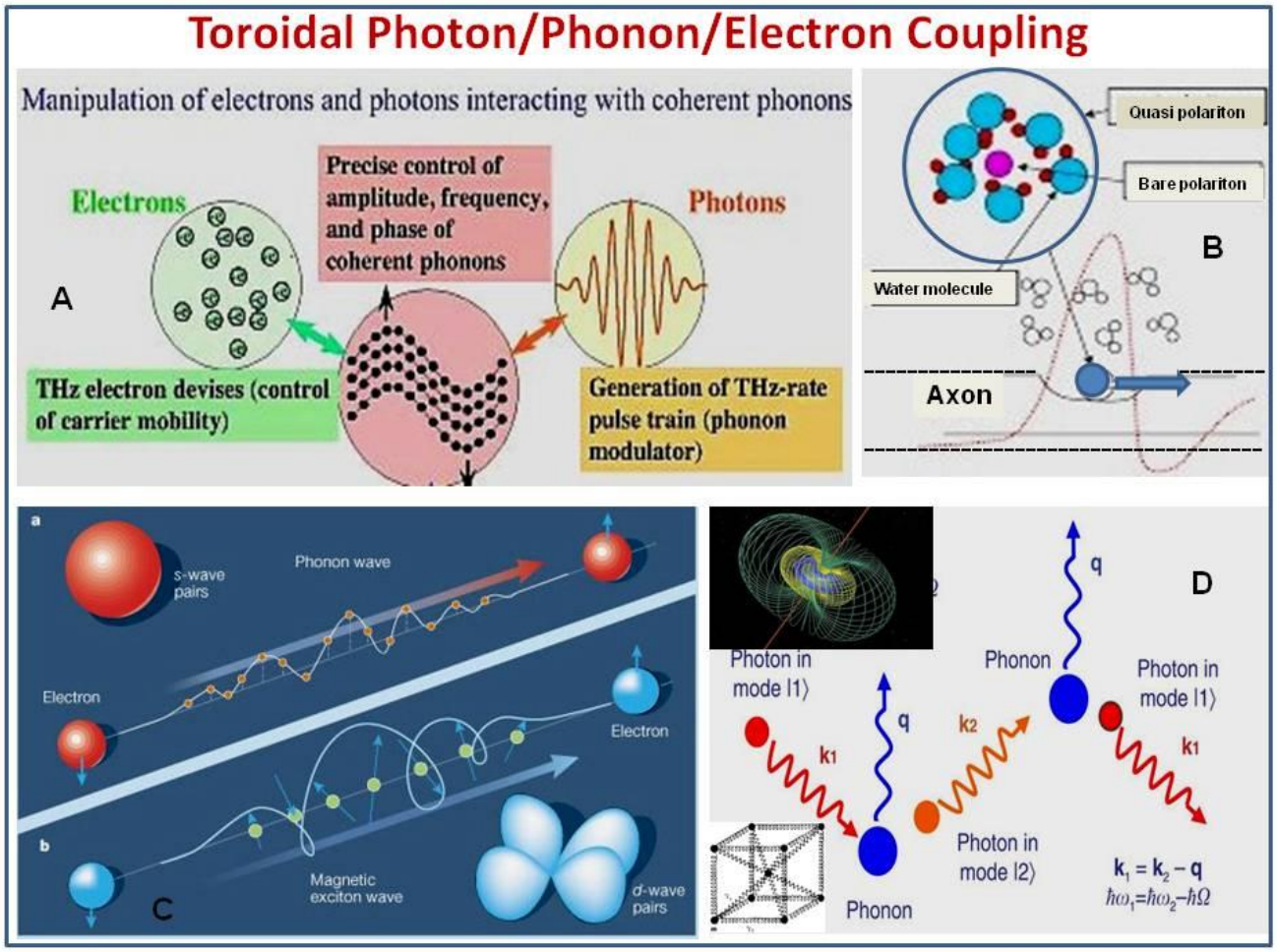

Figure 11. Interaction of photons, phonons and electrons by toroidal coupling to polarons and polaritons. A: THz radiation and interaction of photons and phonons, B: Quasi Polariton propagation along a nerve axon, C: Phonon and electromagnetic waves perturb electron spin, D: Mutual Photon/ phonon interaction.

Phonons exhibit coherent excitation frequencies in the order of 10^9 to 10^{12} Hz (identical to the time domain for functional protein conformational changes, and in the microwave and Terahertz spectral region). Fröhlich has termed these phonons present in acoustic-conformational transitions, and coherent (pumped). Experimental evidence for Fröhlich-like coherent excitations in biological systems includes observation of Terahertz-range phonons in proteins. Optical phonons are often abbreviated as LO and TO phonons, for the longitudinal and transverse modes respectively. Phonons (collective motion) have been detected in water molecules, proteins, and nucleic acids (Hameroff, 2015), and have been measured in

minerals like phyllo-silicates (Geesink and Meijer, 2016).

In relation to consciousness: coherent states are termed for Bose-Einstein condensates and have been suggested by Marshall (1989) to provide macroscopic quantum states which support the unitary binding of consciousness.

The following mechanisms therefore may play a role:

-The toroidal integration of electromagnetic and phonon fluxes of information of scalar standing waves, leading to the induction of signal integration as the basis for conscious perception.

-The geometric organization of coherent arrangement of water molecules and macromolecules in a cellular plasma, leading to guided functional organization of cellular structure and metabolic processes, resulting in life sustaining processes.

- Consciousness makes use of geometrical information fluxes converted to scalar standing waves in a 4-D toroidal topology.

Torus geometry of quantum information as a communication vehicle at various fractal scales related to brain and consciousness and attractors

A theory of consciousness based on quantum oscillations in microtubules was presented by Penrose and Hameroff in the mid-1990s (Hameroff, 1998, updated in 2014). In 2002, molecular modeling suggested electron resonance transfer among aromatic amino acid tryptophan rings in 'tubulin' subunits of microtubules, and from one tubulin dimer to its neighboring tubulin dimer through microtubules in a quantum electronic process necessary for consciousness (Hameroff, 2002). Craddock et al. further showed that anesthetic gas molecules bound in these same regions, and could act there to prevent consciousness. This has been acknowledged as the 'quantum mobility theory' of anesthetic action (Pan, 2008). Physical chemistry research showed that anesthetics bind in non-polar regions via quantum-level van der Waals London 'dipole dispersion' forces involving subtle couplings of π-electron resonance clouds. Craddock and colleagues (Craddock, 2015) have also proposed that 'Quantum mobility' in microtubules mediates consciousness. Consciousness derives from 'quantum channels' of π-stack electron resonance clouds in tubulin and brain microtubule. And stability and vibrational spectra of brain neuronal microtubules will prove to be essential markers of mental health and cognitive function (Post-operative cognitive dysfunction, Alzheimer's disease, traumatic brain injury, depression, stress disorders)

One of us (Meijer, 2014) earlier presented an integrated model for the extended mind, postulating a concept for quantum consciousness, called the bi-cyclic mental workspace, in which the integration of two orthogonally organized fluxes of quantum information provide the potential for conscious perception. On the micro scale a nested organization of quantum information sites was postulated from the Planck scale up to elementary particles, atoms, molecules, and neuronal/astroglial syncytia, in which structure a top-down to bottom-up cyclic information flux is operating. On the macro scale, a complementary, cyclic information flux is operating that is instrumental in the functional binding of local brain cell networks, either induced by entanglement and/or teleportation of quantum information. The particular bi-cyclic mental domain may be organized in a toroidal fashion and produce a more integrated (attractor type) of brain activity (Keppler, 2012). In line with studies from McFadden (2007) and Pockett (2012), we imply that the resulting pattern of recruitment and synchrony of neural activity, is imposed via a combination of the control of coherent electromagnetic fields, in addition to coherent quantum states at far infrared frequencies described by the algorithm. In the latter lateral aspect, a feedback of neural activity, from frontal areas to more posterior cortical areas, may represent a vortex like flow and thereby may be related to conscious experience. This circuitry, seems specifically sensitive to anesthesia and in addition, such recurrent feedback from pre-frontal cortex to other brain regions, such as the thalamus, to correlate with consciousness (Craddock, 2015). These recurrent information processes may also explain quantum communication with internal and external EM fields as well as zero-point energy field (Keppler, 2012; Caligiuri, 2015; Pockett, 2012).

Kozyrev (1997), considered that all life-forms might be drawing information from a

spiralling source of energy. He suggested that life could not be formed in any other way, because it is actively drawing off this spiralling vortex like energy to sustain itself. In this sense, we can think of the living system as possessing efficient resonators for tuning into geometrically organized energy, most likely in the form of toroidal flux patterns as they have been proposed for the modelling of elementary particles up to cosmic macro structures (see section 3). There are recently proposals for toroidal models in the functioning of specific brain cells, neuronal networks, functional parts of the brain as well as the whole brain (Tozzi and Peters, 2015; Knierim and Zhang, 2012). The findings of Tozzi and Peters suggest that nervous structures process information through topological as well as spatial mechanisms. The authors embedded the brain in the 3D space of a Clifford torus and looked on cortical surfaces for antipodal points or shapes in relation to the topological hallmark of a hypersphere. By MRI scanning reproducible topography and propagation has been found through subsets of regions that are shared across multiple trajectories. For example, it has been hypothesized that hippocampal place cells create topological templates to represent spatial information. The spherical structure displays a double torus shape, *i.e*., the trajectory followed by a particle inside the torus is closed. The natural candidate for such a toroidal information flux is the spatially embedded network of the so called human connectome: a non-stationary, highly dynamical structure characterized by complex topological geometry.

The suggestion here is that the brain is embedded in such a hypersphere, which may help to solve longstanding questions concerning our psychological activities such as mind-wandering and memory retrieval or the ability to connect past, present and future events. The human brain exhibits the unique ability to connect past, present and projected future events in a single, coherent, toroidal screen, glued together in a mental kaleidoscope. Interestingly, the authors see the model of the brain hypersphere as a starting point for further evaluation of a nervous' fourth spatial dimension, where mental operations take place both in physiological and pathological conditions and the connectivity patterns at rest might constitute a "signature of consciousness", reflecting a stream of ongoing cognitive processes. They speculate that conscious moments might be correlated with those differences in Clifford torus' structure. In this framework it has been proposed that features of a brain signal with spectral peaks in preferred bands (gamma, beta and so on) provide a basis for feature vectors in a 4D Euclidean space. In one torus type of mechanism, the periodically repeating pattern of so called grid cells in the brain have been related to a supposed toroidal architecture of the attractors (McNaughton *et al.,* 2006). The ultimate test for this model would be direct measurement of the synaptic-connection patterns in the brain and connected glands, which may reveal toroidal patterns in the particular fractal brain regions.

We earlier mentioned the hypothesis that the brain is exposed to coherent electromagnetic fields and quantum resonances at quantized infrared coupled to a zero-point field and collects information through resonance that lead to local attractors (Geesink and Meijer, 2016; Keppler, 2013). An attractor is an assembly of vortex like fields, whose state evolves in time. According to Sæbø (2016): in mathematics there are complex models for information transfer across networks called attractors, and the neural network of our brain can be approximated by these models. Attractor networks are built from nodes (for example neurons) which typically are recurrently linked (loops) with edges (like synaptic connections), and the dynamics of the network tend to stabilize at least locally to certain patterns. These stable patterns are designated as attractors. For example, a memory stored in long time memory may be considered as a so-called point attractor, a subnetwork of strongly connected neurons. An attractor refers also to a collection of states that will eventually attract neighboring states toward that collection, into which self-awareness folds along vortex like fields. Hebb (1949), postulated that coactive populations of neurons form, through plasticity, cell assemblies that have many of the properties now described as signatures of attractor networks. Man-made quantum replicators that are presently under development, show a close relation with the principles of attractors (Meijer and Geesink, 2016a).

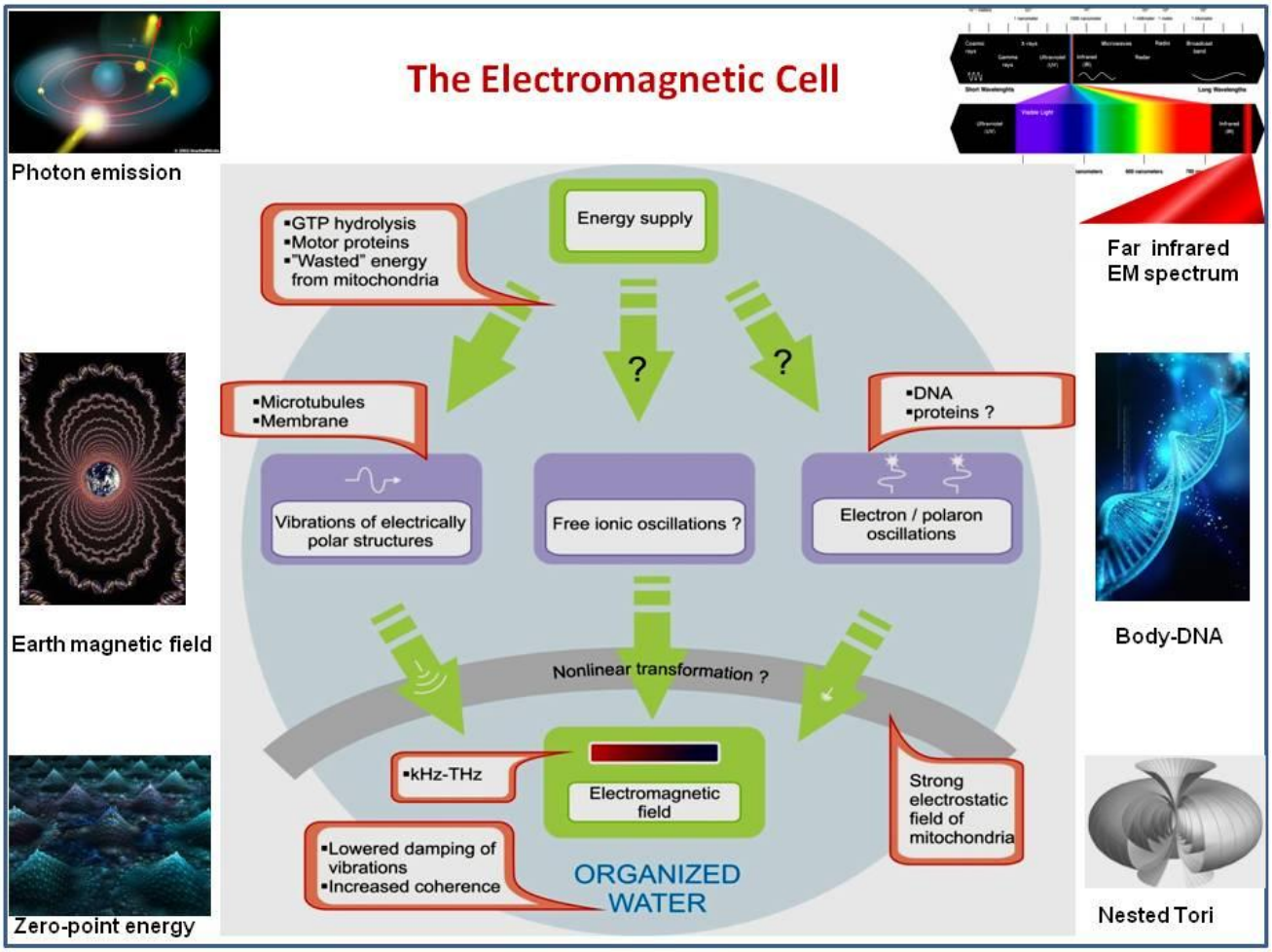

Figure 12. The supposed components of the electromagnetic cell structure and potential interactions with external forces and fields.

It is possible to design such an attractor, based upon assemblies of stabilized ion water clathrates, that in principle, have the capabilities to restore the well-being of test-persons when being exposed to "non-thermal non ionizing radiation".

At least two significant roles for large scale quantum coherence in living systems have been suggested: Herbert Fröhlich's coherent excitations of nonlinearly coupled ensembles of large polarizable molecules, with frequencies in the microwave region, and Fritz Popp's coherent visible photon emission arising from metabolically active cells. The large difference in frequencies has made it difficult to see these two phenomena as being linked (Swain, 2008). A large coupling between these modes, however seems possible and this means a remarkable stability of coherent oscillations over a broad frequency spectrum.

Summarizing: we propose that electromagnetic entities such as photons and phonons, together with electron mediated information fluxes are geometrically collected, protected and converted to scalar standing waves in the topology of 4-D toroidal rotations and that their coupling is realized by the formation of photon/phonon carriers (called polaritons), photon/electron or exciton carriers (polarons) and solitons.

Cellular arrangement of water molecules in cell water in relation to coherent electromagnetic resonance in cells

Water is quantum coherent under ordinary conditions, according to a quantum electrodynamics field theory that may explain many of its most paradoxical properties including life itself (Vitiello, 2001; Jibu and Yasue, 1995; Umezawa, 1993). Quantum fluctuations and coupling between matter and electromagnetic

field in QED predicts quantum coherence for liquid water even under ordinary temperatures and pressures, according to Del Giudice (2009, 2010). This theory suggests that interaction between the vacuum electromagnetic field and liquid water induces the formation of large, stable coherent domains (CDs) of about 100 nm in diameter at ambient conditions, and these CDs may be responsible for all the special properties of water including life itself (Figure 12).

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

Cosic later introduced the idea of dynamic electromagnetic field interactions: that molecules recognize their particular targets and *vice versa* through the principle of electromagnetic *resonance.* An advantage of molecular resonance is that it is extremely selective, to less than 0.01-0.1 percent of the resonant frequency. All molecules have their own spectrum of vibrational frequencies (Cosic, 1994). If the molecule's spectrum contains a frequency matching that of the water CD, it would get attracted to the CD, and become a guest participant in the CD's coherent oscillation, and settle on the CD's surface. There is independent evidence that molecules taking part in a biochemical reaction do share a common frequency, which is how they attract each other, essentially by resonating to the same frequency. It stands to reason that if cell water is exposed to EM field and quantum states in the frequencies detected by us, it will lead to a "geometric imprinting" that resembles the abovementioned Chladni patterns at a much smaller scale and thereby exerts a coherent ordering of cell plasma, including the associated macromolecules. It is of interest that a new quantum state of water molecules was discovered with a 6-fold rotational symmetry, in which the water dipole molecules are arranged in a kind of superposition, that is if they are placed in tiny channels in tiny spaces of the type that also occur in living cells. (Johnson, 2009; Kolesnikov 2016). The particular water clusters posses' unique terahertz frequency vibrational modes in the 1-6 THz range and are supposed instrumental in cellular architecture, protein folding, structuring of DNA/RNA, in addition to EM phonon coupling and specific absorption of gravitational active virtual photons from vacuum fluctuations. In an astrophysical context, the structured water in cosmic dust may contribute to cosmic background radiation and is candidate for baryonic dark matter (Johnson, 2009).

The role of informational Ca2+ ion messenger in the creation of conscious perception

It is well known that "biometals" influence brain health: ions of calcium, sodium, potassium, copper, zinc, iron, manganese, cobalt, and lanthanides, among others are all key cofactors in a wide range of brain cell functions, including cellular respiration, antioxidant removal of toxic free radicals, and oxygen delivery to brain cells. These metals are also cofactors for cell signaling at synapses. In fact, it has been estimated that half of all proteins in the body form complexes with metals.

Earlier, one of us (DKFM) proposed a cyclic mental workspace that could operate at the atomic/molecular and field levels, based on a central role of Ca2+ ions under the control of various neuronal proteins (Meijer, 2015). In this concept Ca2+ is viewed upon as an informational vehicle influencing the activity state of the neuron (Figure 13, partly based on the data of Pereira and Furlan, 2007). 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. The latter may also depend on ultra-rapid conformational changes in proteins in pico-seconds, as influenced by external

electromagnetic fields, and thereby obtain a probabilistic electro-magnetic vibratory character. In turn, local magnetic fields can influence neural firing patterns and induce regional convergent zones of brain activity that are produced through sub-threshold EPSP's and inhibitory inter-neuronal synaptic activity, being amplified by reentry and recurrent circuitry (Pereira and Furlan, 2007). As mentioned in the previous sections, it was inferred by Meijer and Korf (2014), that the ultra rapid responses of the brain cannot only be explained by classical nerve excitation, action potentials, neurotransmitter release and further propagation and integration of neuronal activity. Instead molecular perturbations were suggested mediating high frequency conformational changes in neural proteins that have been shown to exhibit a vibrational state.

Evidence for coherent excitations in proteins has indeed been reported, (see for example Georgiev, 2004; Vos *et al.,* 1993). A so called "poised realm" of reversible coherence/de-coherence process (Kauffman, 2010), could be situated in micro-sites that house such a conversion capability. Mathematician Shor, in 1995 proved a quantum error correction theorem for quantum calculations. If quantum degrees of freedom in a quantum computer are de-cohering due to loss of phase information from the computer (the system) to its environment, then Shor showed that if coherent information is added to the system from the outside, the decohering degrees of freedom turn into recoherence again. In looking for such a system, Kauffman examined the recent research on photosynthetic systems (reviewed by Arndt, 2009; Lloyd, 2014). In photosynthesis photons are captured by the chlorophyl molecule that is held by antenna protein. The chlorophyl molecule maintains quantum coherence for up to 750 femtoseconds. This is much longer than the classical prediction, and is viewed as responsible for the higher than classically predicted efficiency of energy transfer. The particular antenna protein plays a role in preventing more rapid decoherence, or in inducing recoherence in decohering parts of the chlorophyll molecule. Part of the quantum system may start to decohere, but be forced back into coherence, described by the abovementioned quantum error correction. Kauffman thinks that this raises the possibility that webs of quantum coherence or partial coherence can extend across a large part of a neuron, and can remain poised between coherence and decoherence. In this respect, a number of potential intra-neuronal and inter-neuronal connective mechanisms should be taken into account. Solitons, described as dissipative waves or tunneling bio-photons, have been proposed as intracellular local effectors by Georgiev and Glazebrook (2006) and Dotta (2012). Interestingly, even a process of photon quantum teleportation (Salari *et al.,* 2010) have been suggested for long distance signaling in the brain, a process that both employs classical and quantum elements. The generation and maintenance of Ca2+ entanglement in the brain to support conscious processing requires the formation of a protected domain to avoid decoherence (Pereira, 2007). It resembles the abovementioned proposition of Kauffman on poised domain that houses coherence/re-coherence cycles in relation to quantum error correction.

The latter process has been related to topological quantum computing using a *toroidal* approach (Sharma *et al.,* 2006). Such a local geometry is necessary for a highly redundant encoding of information that is relatively insensitive to local perturbations, protecting the quantum resonance state against errors due to interactions with the environment. Pereira (2007) suggests that in the conscious brain phonons are *abundantly present* and controlled by neurobiological mechanisms to generate a large-scale coherent state. This is based on the assumption that electric patterns of neuronal local field potentials affecting the ionic system constitute *elementary contents* of consciousness, while the integration of patterns from distributed fields by means of synchronized oscillations constitute *episodic contents*. The temporal sequence of contents, defined in the domain of interaction of brain, body and environment, was suggested to compose the flux of consciousness. He hypothesized that calcium waves in astrocytes could support cognitive and conscious processing. Superposition and entanglement are therefore considered to be the physical basis for the integration of brain distributed information that supports consciousness.

It was also stated that electromagnetism both initiates and routes vital phonon signals in brain to control biological response. Reimers (2009) suggested that only specific kinds of dynamical Hamiltonians could deliver coherent Fröhlich condensates. Such a condensate would

have properties of specific energy sources as reported by Mesquita et al. (2004) by which, weak coherent condensates within individual proteins may be feasible. They also showed how weak condensation can lead to a significant deviation from the simple steady-state, expected when biochemical processes provide energy to an enzyme. Outside a biological environment, strong or even coherent Fröhlich condensation could occur when an optical or another external energy man–made source will directly be coupled to a set of oscillators, for example in a microwave or terahertz region. These scenarios could produce conditions necessary for condensation, concentrating energy within specific parts of a system even in the presence of a low-temperature bath.

It should be mentioned in this respect that DNA in our cells is also capable of receiving sound (phonons) and light (photons) and it may act as a resonator that attracts with electromagnetic energy and communicates with cell components and other cells through specific EM frequencies. The internal quantum signal guiding in the DNA molecule may be tuned to vibrations of phonons (Huelga and Pieno, 2013; Dorner *et al.,* 2013; Lambert *et al.,* 2013) and it has been recently suggested that the stability of DNA structure is even directly dependent on the continuous input of phonon guided oscillations (Rieper *et al.,* 2010).

A contribution to the problem of information integration in the brain is to combine classical computational mechanisms with Ca2+ superposition/entanglement, since this ion is active in an assembly with other ions at all brain regions and could function as a communication channel to integrate classically encoded messages, and support the phenomenon of psychological "binding", the union of features processed in several areas of the brain. The calcium atom electronic structure is unstable, with a short life (around 7 nanoseconds), and therefore the ion will spontaneously return to the ground state, emitting an electromagnetic radiation, or will change to the *dark* state, without an immediate photonic emission. The supposed brain's protectorate is therefore generated by the conversion of *phononic noise into* information, which mechanism is probably operating inside astrocytes. The conscious state would then be physically based on the survival of a multi-particle entanglement affected by decoherence of some of the previously entangled particles. The stream of consciousness is seen to be composed of a sequence of coherent states along time.

Sophisticated phonon initiation and routing directs also conformational protein adaptation attributed to "activation of specific EMF sensitive enzyme systems that modulate calcium entry." Davies and Norris, 2004, demonstrated that Ca2+ dependent motility in marine diatoms, was substantially enhanced by EMFs. Gibbs *et al* (2006) demonstrated cysteine rich secretory protein domains regulate ion channel activity, "and provide evidence for a role in [Ca2+] regulation". Rosen, 1996, refers to Ca2+ channel deformation from "anisotropic diamagnetic" phospholipids in the cell membrane that might be expanded to incorporate many other PDCs, and transitional metals. Vendel (2006), further notes: "these domains that regulate cell surface expression and movement of Ca2+ voltage gated alpha sub-units involve five domains related to, "a large family of membrane-associated guanylate kinase proteins", conformational adaptation suggested to be a (phonon) signal series driven outcome. Mustafi *et al.* (2004) reported essentially similar findings in terms of multiple domains as part of "paramagnetic interactions in between Ca2+ and diamagnetic lanthanides".

The direct relation with the N-methyl-D-Aspartate channel (NMDA), that after depolarization binds glutamate and thereby allows Ca2+ entry into neurons and induces oscillatory synchrony, seems crucial. Interaction of general anesthetics with NMDA receptor/channel function have been shown to induce the loss of consciousness (Flohr, 1998). The magneto-sensitivity of Ca2+ is well known (Adey, 1993; Liboff, 1985) in the sense that calcium transport and protein/channel binding is affected by magnetic fields with ELF radiofrequency signals in the range of 7.0 Hz. The influence of this signaling of, so called, Ca-ion cyclotron resonance is supposed to be due to the induction of exclusion zones in the structured state of cytoplasm water molecules forming coherent domains (Brizhik, 2013).

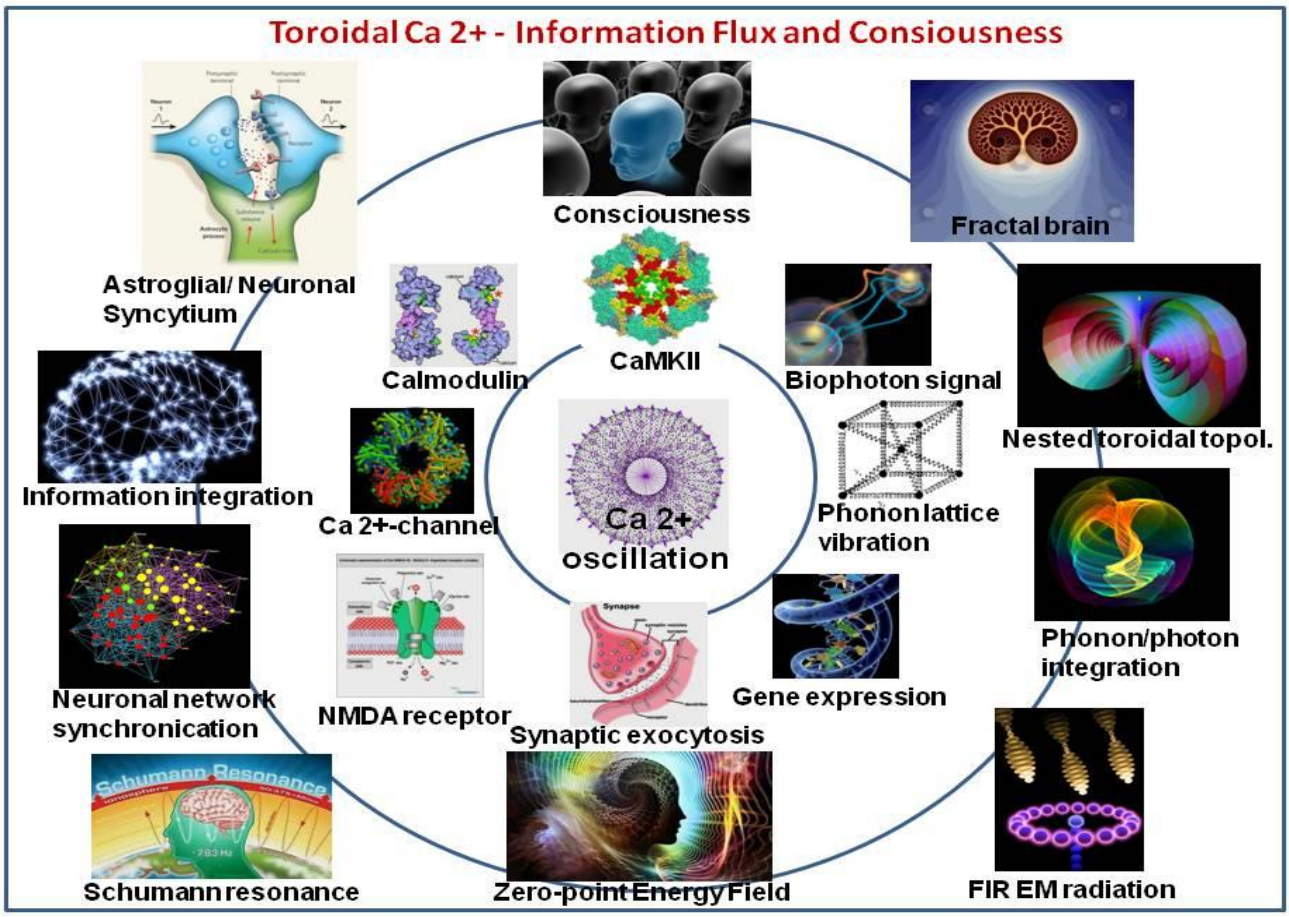

Figure 13. The fractal organization of Ca2+ mediated cellular mechanisms related to conscious perception. The pivotal role of Ca2+ ions as informational second messengers in brain function is indicated at micro and macro levels. Inner circle depicted anti-clockwise: Neuron/astrocyte mediated Ca2+ ions flux lead to activation of Calmodulin associated kinases (CMK11), calmodulin, NMDA-receptor/channel proteins and quantum resonance within Ca-channels that may stimulate synaptic neurotransmitter exocytosis. Outer circle macro scale: Ca2+ flux in syncytia of neurons/astrocytes lead to phonon/photon mediated information storage and integration as well as neuronal assembly and neuronal network synchronization. Ca2+ messenger function may be influenced by Schumann and cyclotron resonances as well as Zero-point energy (ZPE) and far infrared (FIR) radiation resonance. The resulting phonon and photon scalar waves in the brain are integrated and protected against decoherence through toroidal processing. Topological integration on the brain macro scale is realized by torus nesting and self-similar fractal representation. This integral process may contribute to the creation of awareness and conscious perception in relation to the external world.

How is all this related to consciousness? According to Nunn, 2015, mind can usefully be regarded as a process by which complex entities assign meanings to incoming information in relation to information that is already stored, that is subsequently adapted by the new information. Only *fractal* structures may capable of achieving this, and the fractality has to be present temporally as well as spatially that can be well imagined by ion fluxes with their associated electrical fields. Nunn argues that the calcium ion fulfills the requirement for a wide range of spatial scales of order in any fractal structure and is generally regarded as a primary mediator of instantiation of 'mind' in the brain. Ordered calcium ion fluxes are known to occur on spatial scales ranging from that of dendritic spines to assemblages of astrocytes that form syncytia because of their numerous gap junctions. These fluxes are driven by fluxes of other ions and local electrical fields, along with the activity of calcium channels and uptake into various types of calcium stores. They also operate on various temporal scales ranging from brief release of small packets of ions within dendritic spines to the relatively slow calcium in astrocytes.

This special fractal scaled Ca2+ behavior is that astrocytes very likely support functions additional to the normal neuronal mechanisms. In fact, they contribute directly to cognitive functions and resultant behavior (Pereira and Furlan, 2009; Fields, 2013; Mitterauer, 2013;

Bull, 2014). Grafted human astrocytes in mouse brain that have a higher rate of Ca2+ flux and are much larger and more complex than the mouse cells showed enhanced learning, memory and plasticity (Han *et al.,* 2013; Fields, 2013). An important aspect of this 'calcium ion' hypothesis of mind is that any instantiation of mind should be intimately connected with early stages of memory processes. This is a requirement is essential to 'mind' since it should be capable of dealing with the new incoming information establishing new attractors in the "domain" of consciousness and also must be capable of integrating different aspects of incoming information over time. Calcium ions directly activate CaMKll: the higher the local calcium ion concentration the longer the proteins remain activated until, exceeding a critical local ion concentration, they switch to a permanently active state. As treated above, this affects a wide spectrum of functions such as the facilitation of synaptic long term potentiation, important to long-term memory.

Nunn (2015), suggests a form of 'neutral monism' at the basis of reality in which consciousness and matter comprise a fully integrated entity that lies in events associated with the manifestation of energy eigenstates. Nunn speculates that energies associated with calcium ion behavior (e.g. transport and ion/protein binding) will exhibit required small uncertainties and thereby allow a direct mapping from 'mind' to the field of consciousness. Does this offer any insight into the qualia differentiation problem? Nunn points to information fluxes as trajectories on geometric surfaces that are topologically equivalent to knots, that can be envisioned to exist in the brain in some form. Since his supposed fields of subjectivity are seen as relating primarily to time/energy, whereas the behavior of the objective world often relates more to position/momentum, any back action of conscious fields on the objective world might be expected to show itself most clearly in temporal and perhaps even energy-related physical anomalies. Faraday's and Chladni filings patterns, as mentioned earlier, allow the visualization of quantum fields and may provide such an example. Analogous to a material force field, local distortions of space-time, and quantum wave probabilities may play a role here. Qualia have been viewed upon as direct correlates of fractal structured, energetic processes and such inherently small energy uncertainties may also embody a knot-theoretical topology. As mentioned earlier, torus geometry allows knot trajectories and may represent scalar eigenstates. Each of these requirements may become testable as brain imaging methods and related analyses improve to the extent that correlates of (self)-consciousness could be approached. Ho (2013) stipulates that nested space-time structures in organisms optimize the efficiency of thermodynamics, by enabling the simultaneous exploitation of very slow and very fast energy transfers with minimum dissipation, in spite of the fact that living fractals, in principle, remain distinct activities. Yet the fractals are close to harmonics that resonate, thereby achieving a sort of phase coupling by sliding from harmonic to fractal states in which local connects with global. Such a nested mechanism may explain how quantum waves at various geometric scales in the brain can provide coherent information fluxes from micro to macro scales.

On the basis of our specific frequency data and the known sensitivity of Ca2+ to EM radiation, we fully support the notion that Ca2+ takes a crucial position in the integration of the distributed information within the brain, not only due to its specific atom electronic properties and its potential for entanglement and superposition, but also since it affects at least 10 different cellular processes that have been shown to correlate with modalities of conscious perception (reviewed by Pereira, 2007; Pereira and Furlan, 2007, see also Figure 13). Interaction of general anesthetics with NMDA receptor/channel function have been shown to induce the loss of consciousness (Flohr, 1998).

In addition, phonon patterns affect trapped Ca2+ ions in astrocytes, a process that is instrumental in the formation of quantum information states that in the astroglial/neuronal "protectorate" may survive decoherence (Pereira, 2007). Interestingly the magneto-sensitivity of Ca2+ is well known (Adey, 1993; Liboff, 1985) in the sense that calcium transport and protein/channel binding might be affected by magnetic fields with ELF radiofrequency signals in the range of 7.0 Hz. The influence of this signaling of, so called, Ca- ion cyclotron resonance is supposed to be due to the induction of exclusion zones in the structured state of cytoplasm water molecules forming coherent domains. Biological effects are influenced by oscillating magnetic fields, depending on their

frequency. Cyclotron resonance of ions is induced by alternating magnetic fields, in which the circular motion becomes superimposed on the axial one, resulting in more complex trajectories that seem similar to toroidal topology. This may in turn lead to lattice deformations that affect binding and transport of Ca2+ (see review of Brizhik, 2013). Among others, Ca2+ oscillatory patterns can affect gene expression (Ozil *et al.,* 2006). We argue therefore that the induced storage of energy is mediated by toroidal phonon information flux, that imposes a spectrum of Chladni-type of geometric patterns in the cytoplasm. EM fields act as forcers to create phonon-driven non–linear information processing, since phonons conduct acoustic information along protein lattice networks at the speed of sound (Kriegl and Niehaus, 2004). The resulting coherent resonance structures subsequently interact with cell components and contributes to ordering of life processes such as the above second messenger function of Ca2+ ions.

Finally, we want to emphasize that general ordering of the functional architecture of cells is obviously not sufficient to explain the fine tuning of life: clearly, deeper, subtler, levels of dynamic organization are required. It was recently pointed out by Görnitz (2016), that we do know very little of the fabric of reality from the size of the electron down to the Planck scale, and that it is a misunderstanding that going smaller makes understanding more simple. This is also true for explaining life: Grandpierre (2011) postulated that "DNA works with the help of a factor that is utterly beyond DNA or any other material life system physical capabilities. This something is immaterial yet effective and belongs to science. This is the first principle of biology that acts as a deeper intelligence of the "vacuum", in the sense that it virtually maps all the possible histories, summarizes the results of this mapping on its own basis and then decides about the biological endpoint and from there, and finally "chooses" the optimum physically realizable "path".

7. Conclusions and final discussion

Hawking noted in A Brief History of Time: "The universal force of electromagnetism controls all biological response", applicable here just as in Pauling's more classical derivation (Nobel lecture, 1954). Diurnal fluctuations shared by living systems and the SR constitute epochal evidence that native phonon vibrations are shared among proteins to control cell function throughout the hierarchy of living systems.

We recently found a highly significant correlation between the theoretical (algorithmic) frequency scale and the experimental frequency data related to the viability of cells in 175 *in vitro* and *in vivo* life studies (bandwidth of 0.78%), for which 97 different frequencies were used in a range of 0.4 Hz up to Peta Hertz (Geesink and Meijer, 2016). In the present study, we show that our EM radiation frequency data almost exactly agree with the physical frequency data of Chladni and Ritz, inspecting the scalar values for eigenfrequencies as positioned in the chosen scales. Interestingly, Schrödinger in 1926 used the same type of acoustic wave characteristics to describe 3-dimensional wave functions of the H-atom according to the well known the Schrödinger equation.

It can be inferred that a stability of conformational states of waves is attained at a minimum energy, when the frequencies fit with the first harmonic (1:2), and fit somewhat lesser, but close to the second harmonic (2:3) and somewhat lesser with the third harmonic etc. This means that "the initial value problem can be solved", due to the fact that six of the basic frequencies are based upon powers of 2 and 3, and match with the first and second harmonics. This implies that six basic frequencies, in a scale of twelve frequencies, are positioned at: 256, 288, 324, 384, 423 and 486 Hz and other frequencies in between are located to approach these harmonics and higher scalar frequencies can be calculated by multiplying or dividing by 2. It seems that the many different Chladni patterns, that have been shown over a wide spectrum of different frequency scales are eigenfrequencies of geometric shapes, that is, if the dimensions, the E-modulus and density of the thin vibrating plate are exactly defined. Of note, the material and design properties of the plate have to match precisely with the eigenfrequency (called "Eigenton by Chladni") of the plate, and represents one of the scalars of the algorithm, which uses a power of 2 and 3 (n is an integer). Chladni used an "Eigenton" of 96 cycles/sec in his experiments, which in acoustics is similar to a G. This matches precisely with 384 Hz at two lower octaves (see the tables in appendix 1 and appendix 4).

In this respect, there is also a striking relation with the earlier work of Fröhlich et al. 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). The particular organisation of conformational states of cells were described by him as microwave and far infrared frequencies and likely represent the patterns described by our algorithm.

It can finally be concluded that:

1) Our earlier reported algorithm of life matches precisely with the mathematical calculations of W. Ritz (1909) and the physical membrane experiments of E. Chladni (1787) and that it is possible to reproduce the Chladni experiments carried out in 1787, and to describe the eigenfrequencies with our algorithm.

2) For the acoustic, phonon guided principle, a torus model is proposed, making use of the basic principles of the Neo-Riemannian Tonnetz, which is extended with sequences of twelve basic intervals described by the algorithm. In the centre point of the torus all waves converge as well as diverge at typical algorithmic infrared frequencies.

3) Quantum states at far-infrared can be considered as co-instrumental in the fractal and geometric organization of information flux in the astrocyte/glial/neuronal network, through the toroidal formation of phonon/photon scalars as a fundamental basis for conscious perception.

We consider our life principle hypothesis as testable. For example, specific and scalar EM radiation could be externally applied in *in vitro* and *in vivo cell* studies, in order to induce beneficial resonance of oscillating cell components such as proteins and oligo-nucleotides that sustain life. In this framework, the influence of endogenous and exogenous electromagnetic fields in relation to brain function and consciousness, as have been reported in a wide spectrum of recent neurophysiological studies (McFadden, 2007; Pockett, 2012; Libet, 1993; John, 2001) could be further extended.

Biofield physiology has been extensively reviewed now as an emerging discipline (Hammerschlag *et al.,* 2015; Muehsam and Ventura, 2014; Cifra *et al.,* 2010; Fels, Cifra, Scholkman (eds), 2015), in which biologically generated fields are defined as spatially distributed sets of physical forces and properties that have the capacity to encode information and exert instructive influences on life systems, that are able to perceive such fields and provide a back-reaction to them. It is of great importance that direct experimental evidence has been found recently for the Fröhlich condensation, as a mechanism for long range quantum coherent states of proteins and DNA in life systems (Lundholm at al., 2015) and that several advanced optical methods are available now for detection of responses and collective modes of such large biomolecules in the terahertz frequency range (Markelz, 2008), including NMR-frequencies as shown, for example, in (Ca2+)-calmodulin (Chou *et al.,* 2001).

Our concept on electromagnetics for life processes and brain function is also in line with the current spectrum of pre-clinical and clinical studies on the application of EM radiation as reviewed among others by Tabrah (1990), Reite (1994), Dutta (1994), Belyaev, (1998), Golgher (2007), Hernández-Bule (2007), Wei (2008), Adamskaya (2011), Weng (2011), Choi (2012), Brizhik, (2013), Kang (2013), Fröhlich F. (2014), McCormick and Brumberg (2000), Pereira (2002), and Battleday et al (2014).

It is highlighted in the present study, that the frequencies of the 'Life principle' are present as eigenfrequencies of *nested* tori. We consider the torus as a fundamental property of spacetime, that enables the processing, coupling and integration of various modalities of wave information such as photons, phonons and electrons, in which the nested topology stands for holographic and fractal aspects, that extend to both macro and micro scales. The frequencies in such tori were earlier estimated by integrating orthogonally organized fluxes of eigenvectors of symmetric matrices, such as square plates, cylindrical areas of bells, and torus surface as described by neo-Riemannian theorists. It is further hypothesized by us that 3-D and 4-D eigenfrequencies are coupled to far infrared eigenfrequencies, in the framework of the torus geometry and analogue to the principles of a Fröhlich-Bose-Einstein condensate. Of note, the far infra red frequency range is exactly in between the wave frequency ranges of the photon and the electron and can probably constitute both standing and longitudinal waves.

The identical EMF frequency bands of life sustainment, clay mineral quantum wave replication and sound induced geometric forms indicate that this biological/physical principle operates in both non-animated and animated systems and may have bridged information processing required for first life. The interplay of such discrete electromagnetic radiation frequencies in the guiding of cellular function, shows that life systems can obtain sufficient external information to explain their integral life complexity and will further invite studies into the conformational state and functional information networks of living cells.

Based on the material presented in the present paper, the following novel axiom/biological principle might be at stake: nature makes use of specific set of eigenfrequencies of electromagnetic waves as well as of quantum states, that exhibit frequency ratios of 1:2, and closely approximate 2:3 and 3:4 and higher partials, that can be expressed in scalars. These frequencies may provide a vibrational spectrum that can resonate with cellular "antennae" in the form of informational ions such as Ca2+. In addition, plasma-, channel-, and tubular proteins as well as oligonucleotides in the cell, may also both absorb and emit quantum wave information. We propose that such a dynamic electromagnetic network provides the very basis for the ordering and functional integration of cells, and may provide the fundamental basis for the creation of awareness and (self) consciousness.

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Appendix 1

Table Ritz/Chladni

Table Ritz/Chladni , Handbuch der Physik H. Geiger und Karl Scheel, Bd. VIII, 1927.

Tabelle 23. Quadratische Platte. Hauptglieder $u_h v_k \pm u_k v_h$ der Ritzschen Entwicklungen nach Stabfunktionen $u_h = u_h(x)$ und $v_h = u_h(y)$. Daraus berechnete Frequenzparameter λ und relative Tonhöhen, wenn als Höhe des tiefsten Eigentons $u_1 v_1$ das große G mit etwa 96 Schwing./sek angenommen wird, in Spalte „ber."; entsprechende von Chladni beobachtete Werte in Spalte „beob.". Die Glieder mit Doppelvorzeichen $\pm$ entsprechen den Doppeltönen, d. h. Tönen mit zwei verschiedenen Systemen von Knotenlinien.

Hauptglieder	λ	berechnet	beobachtet	Hauptglieder	λ	berechnet	beobachtet
$u_1 v_1$	12,43	G^*	G	$u_3 v_4 \pm u_4 v_3$	3240	g_3+	fis_3
$u_0 v_2 - v_0 u_2$	26,40	d^*	d	$u_5 v_2 \pm u_2 v_5$	3927	a_3+	gis_3+
$u_0 v_2 + v_0 u_2$	35,73	e^*	e	$u_4 v_4$	5480	ais_3+	ais_3
$u_1 v_2 \pm u_2 v_1$	80,8	h^*	h	$u_0 v_6 - u_6 v_0$	5500	c_4-	—[3]
$u_0 v_3 \pm u_3 v_0$	237,1	gis_1^*+	gis_1+	$u_3 v_5 - u_5 v_3$	5570	c_4-	ais_3-
$u_2 v_2$[1]	266,0	ais_1^*-	ais_1^*-	$u_0 v_6 + u_6 v_0$	5640	c_4-	—[3]
$u_1 v_3 - u_3 v_1$	316,1	h_1^*	h_1	$u_1 v_6 \pm v_1 u_6$	6036	c_4+	c_4-
$u_1 v_3 + u_3 v_1$	378	cis_2^*	cis_2	$u_3 v_5 + u_5 v_3$	6303	cis_4	c_4-
$u_2 v_3 \pm u_3 v_2$	746	fis_2^*+	fis_2	$u_2 v_6 - u_6 v_2$	7310	d_4+	cis_4+
$u_0 v_4 - v_0 u_4$	886	gis_2	gis_2	$u_2 v_6 + u_6 v_2$	7840	dis_4-	d_4-
$u_0 v_4 + v_0 u_4$	941	gis_2+	gis_2+	$u_5 v_4 \pm u_4 v_5$	9030	e_4	dis_4
$u_1 v_4 \pm u_4 v_1$	1131	ais_2	ais_2-	$u_6 v_3 \pm u_3 v_6$	10380	f_4	e_4
$u_3 v_3$	1554	c_3+	c_3	$u_5 v_5$	13670	g_4+	fis_4+
$u_2 v_4 - u_4 v_2$	1702	d_3-	cis_3	$u_6 v_4 - u_4 v_6$	13840	g_4+	g_4+
$u_2 v_4 + u_4 v_2$	2020	dis_3	d_3	$u_6 v_4 + u_4 v_6$	15120	gis_4+	g_4+
$u_0 v_5 \pm v_0 u_5$	2500	f_3-	f_3-	$u_6 v_5 \pm u_5 v_6$	20400	h_4	ais_4-
$u_1 v_5 - v_1 u_5$	2713	fis_3	fis_3-	$u_6 v_6$	28740	d_5	—[3]
$u_1 v_5 + v_1 u_5$	2945	fis_3+	fis_3[2]				

Die mit * versehenen berechneten Töne stimmen vollkommen mit den beobachteten überein.

[1] In der Tabelle bei Ritz infolge Druckfehlers als $u_1 v_1$ bezeichnet.
[2] Von Chladni von dem vorigen Ton nicht getrennt.
[3] Von Chladni nicht beobachtet.

Figure 14

Appendix 2

Modern measurements of Chladni patterns 1970-2013

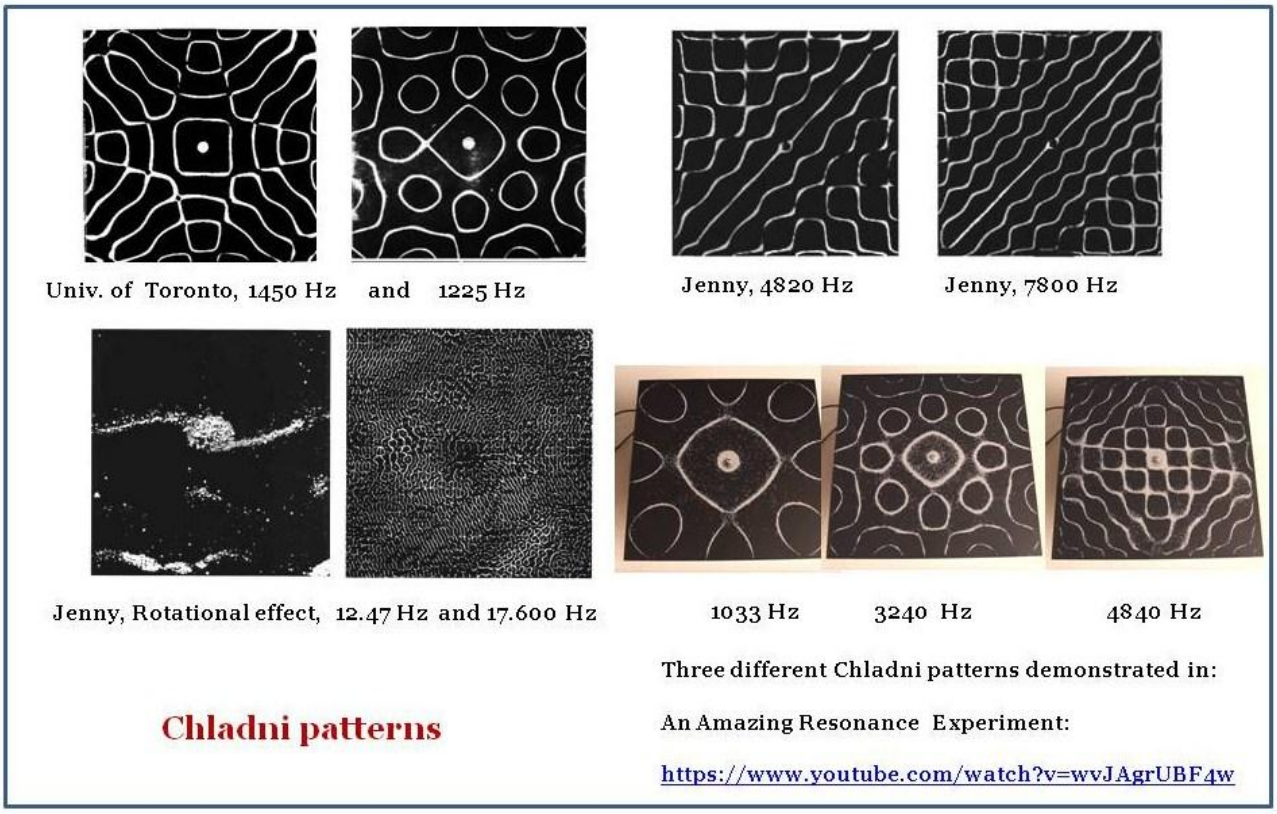

Figure 15

Appendix 3

Frequency data Ritz/Chladni and modern experiments

Data Graph 1. Ritz/Chladni eigenfrequencies square plates (1909): 96, 139.9, 162.7, 224.7, 419.2, 444.1, 484.1, 529.3, 743.6, 810.4, 915.6 , 1073.3, 1123.2, 1223.7, 1361.3, 1477.5, 1549.8, 2019.2, 2327.8, 2410.7, 2587.2, 2161.5, 2410.7, 2773.9, 3203.0, 3888.7, 4615.6 Hz.

Data Graph 2. Modern Chladni experiments square plates (1970-2013): 142.2, 190, 340, 345, 490, 800, 955, 1033, 1225, 1450.2, 1820 Hz.

Data Graph 3. Modern Chladni experiments square plates (1970-2013): 2041, 3240, 3678.1, 3835, 4129, 4221, 4280, 4671, 4840, 5201, 5875.5, 5907, 6051, 7800, 17600 Hz.

Appendix 4

How to derive the electromagnetic life principle, using a simple scheme

In calculating the frequencies of the life principle, we will follow the metric of tone scales, as Schrödinger did to describe the 3D wave functions of the H-atom. Ritz and Chladni discovered the eigenstates and frequencies of standing waves for thin vibrating square plates, at the lowest possible energy level, considering the knowledge of tone scales. Chladni patterns have also been found by Hibbert, 2014, for partial tone frequencies of 3D bells, which show whole number ratios for frequencies: 1:2, 2:3, 3:4, etc. The Tonnetz has been used by neo-Riemannian theorists to

describe a helical path of intervals on a 3D torus surface. Pythagoras found that harmonious intervals of musical notes have whole number ratios: 1:2, 2:3, 3:4 to describe a tone scale. In this way, Pythagoras described the first four overtones which create the intervals which have become the primary building blocks of musical harmony: *the octave (1:2), the perfect fifth (3:2), the perfect fourth (4:3) and the major third (5:4).*

To understand the principle of stacking fifth's we will follow the analysis of Laura Smoyer (2005): "Western music has been based on the seven tone Diatonic scale, as used by the Ancient Greeks. During the middle ages, five pairs of tones, known as sharps and flats, were interspersed in this Diatonic scale to produce the modern twelve-tone scale":

C D E F G A B Diatonic Scale

C# D# F# G# A# sharps

Db Eb Gb Ab Bb flats

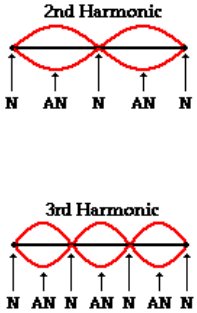

Figure 16

Referring to the musical scale, the terms octave, fourth, fifth etc. are used to describe the *intervals* between notes. These extra intervals are never expressed as fractions of the wave form, but rather in whole numbers, since induced acoustic waves should always fit the given space of the vibrating string, determined by the fixation of the string at both ends. Also they should refer to the original diatonic scale. This implies that as a first approximation for the tonal frequencies, whole number values should be identified that can both be divided by 2 and 3. An octave refers to the eighth note of the diatonic scale, a fourth the fourth note, and a fifth the fifth note. On the C-scale, an octave is the next higher or lower C, a fourth is F, and a fifth is G:

1st 2nd 3rd 4th 5th 6th 7th 8th

C D E F G A B C

Therefore, these intervals in fact existed long before they were ever named: the human ear naturally prefers certain pairing of notes. Over time, a scale was developed, grouping a set of musically harmonious notes (subject to cultural norms), and then the intervals were named. The octave, fifth, and fourth are perceived as more consonant than any other interval to the western ear. If two notes, separated by one of these favoured intervals, are played simultaneously, the resulting tone actually sounds louder than a random interval (Fauvel, Flood and Wilson, 2003, p.62). The Pythagoreans worshipped whole numbers and held a belief that whole numbers could be used to explain systems present in the natural world. The most harmonious interval is commonly thought to be an octave; a fifth is generally agreed to be the second most harmonious interval, and the Pythagoreans based their explanation of their scale on this interval.

The Pythagoreans showed that if a given base note is multiplied repeatedly by the frequency ratio used to find a fifth: 3/2, all the other frequency ratios for the notes in the Diatonic scale can be created. The goal is to reproduce the eight-note Diatonic scale by starting at a root note and

going up the six intermediate notes before arriving again at the root note transposed up an octave. Such a scale will have ratios with values between 1 (the root note) and 2 (the root note transposed up one octave). If the transposed fifth is outside of this range, the product is multiplied by 1/2. This transposes the note down an octave, and brings the ratio into the desired range. This method produces the frequency ratios for five of the six missing notes. The frequency ratio for the final note, a fourth, is found with a slight variation to this method: the frequency ratio for the upper octave, 2/1, must be divided by 3/2 (Fauvel, Flood and Wilson, 2003, p. 16). The end result is a scale produced by playing strings whose relative lengths are determined by the following frequency ratios:

$$\frac{1}{1}, \frac{9}{8}, \frac{81}{64}, \frac{4}{3}, \frac{3}{2}, \frac{27}{16}, \frac{243}{128}, \frac{2}{1}.$$

Using this method, the interval between each note on a given scale can then be calculated:

$$\begin{array}{cccccccc} (C & D & E & F) & (G & A & B & C) \\ \frac{1}{1} & \frac{9}{8} & \frac{81}{64} & \frac{4}{3} & \frac{3}{2} & \frac{27}{16} & \frac{243}{128} & \frac{2}{1} \\ & (\times\frac{9}{8} & \times\frac{9}{8} & \times\frac{256}{243}) & \times\frac{9}{8} & (\times\frac{9}{8} & \times\frac{9}{8} & \times\frac{256}{243}) \end{array}$$

The Pythagoreans named their scale diatonic (dia-across, tonic-tone) because it is based on two tetrachords (four notes that span the interval of a perfect fourth: 4:3) separated by a whole tone.

The Pythagorean scale can be expanded to include sharps and flats, which are semi-tones. These intermediate notes divide the whole tones in the Diatonic scale. In theory, the sharps and flats fall in the middle of each pair. In practice, the addition of sharps and flats exposes a distinct flaw in the Pythagorean scale: the scale including sharps and flats are not exactly in the middle of the basic 8 whole tones. If they were in the exact middle, C# and Db, for instance, would be the same note and should have one name. The problem stems from the fact that two Pythagorean semitones, 256/243 x 256/243, do not quite equal a Pythagorean whole tone, 9/8 (Fauvel, Flood, Wilson, 2003, p.16):

$$\left(\frac{256}{243}\right)^2 = 1.109857915 \qquad \frac{9}{8} = 1.125$$

$$\sqrt{\frac{9}{8}} = 1.060660172 \qquad \frac{256}{243} = 1.053497942$$

The intermediate note, therefore, cannot be placed exactly in the middle, because the semitone is a key ingredient to the original diatonic scale and corrupting this semitone would change the sound of two of the basic eight intervals. Instead, the frequency ratio for a flat is calculated by multiplying the whole note that precedes the flat by a semitone 256/243. The frequency ratio for a sharp is calculated by dividing the whole note that follows the sharp by a semitone 256/243. Through the medieval period, the small difference between two semitones and a whole tone caused little problems, because composers generally wrote music for one key. Instruments were usually tuned by starting at Eb and moving up by fifths (because this favoured interval is the easiest to "hear") eleven times to produce a twelve-note scale, Eb, Bb, F, C, G, D, A, E, B, F#, C#, G#.

The proposed life electromagnetic frequency principle

To calculate the basic scalars of the principle, we propose to apply the principle of intervals of 1:2, 2:3 and 3:4 for seven scalars of a reference scale as proposed by Pythagoras in the diatonic scale. The five intermediate scalars are subsequently determined according to the Pythagorean

calculation for flats. The particular "flat calculation" approximates more precisely the necessary whole numbers than the "sharp calculation" for semitones (Table 1).

Combining both conditions, the following reference scale of scalars can be calculated: 256, 269.7, 288, 303.4, 324, 341.3, 364.5, 384, 404.5, 432, 455.1, 486 Hz. All additional parts of the final entire frequency scale, representing the lower and higher frequencies ranges (from values less than 1 Hertz and those ranging at far infrared frequencies) can subsequently be calculated by multiplying or dividing each scalar of the abovementioned reference scale by 2 (again a whole number).

We have also verified the so constructed reference scale, that very well matched the electromagnetic frequencies of our life literature survey, in the context of the frequency data mentioned in patent: *Mineral composition EP 1834926*. It could be concluded that all frequencies described by the diatonic scale fit exactly the radiation frequency data of the chosen phyllosilicate clay material. In fact, the semitones had to be adjusted less than 0.1% per scalar, which implies that the mean difference over 12 scalars is only 0.02%, which is obviously very small.

Based upon this feature, we propose to employ the version with small adaptations for these four scalars, thereby arriving at the following slightly adapted reference scale: 256, 269.8, 288, 303.1, 324, 341.2, 364.7, 384, 404.5, 432, 455.1, 486 Hz, as earlier mentioned. The same scale calculated at a frequency ratio from 1 till 2 is as follows: 1.00, 1.06, 1.13, 1.19, 1.27, 1.33, 1.43, 1.50, 1.58, 1.69, 1.78, 1.90, 2.0.

		PYTHAGOREAN		
ordinal	*note*	*Freq. ratio*	*Decimal*	*Cents*
octave	**C**	1	1	**0**
	C$^{\#}$	$\frac{2187}{2048}$	1.0679	**114**
	D^{b}	$\frac{256}{243}$	1.0535	**90**
second	**D**	$\frac{9}{8}$	1.1250	**204**
	D$^{\#}$	$\frac{19683}{16384}$	1.2014	**318**
	E^{b}	$\frac{32}{27}$	1.1851	**294**
third	**E**	$\frac{81}{64}$	1.2656	**408**
fourth	**F**	$\frac{4}{3}$	1.3333	**498**
	F$^{\#}$	$\frac{729}{512}$	1.4047	**612**
	G^{b}	$\frac{1024}{729}$	1.4047	**588**
fifth	**G**	$\frac{3}{2}$	1.5000	**702**
	G$^{\#}$	$\frac{6561}{4096}$	1.6018	**816**
	A^{b}	$\frac{128}{81}$	1.5802	**792**
sixth	**A**	$\frac{27}{16}$	1.6875	**906**
	A$^{\#}$	$\frac{59049}{32768}$	1.8020	**1020**
	B^{b}	$\frac{16}{9}$	1.7778	**996**
seventh	**B**	$\frac{243}{128}$	1.8984	**1110**
octave	**C**	2	2	**1200**

Table 1. Calculations of semitones in a flat situation (Smoyer, 2005).