Universal rhythm for communications between animals?

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Abstract

The study by Guy Amichay, Vijay Balasubramanian, and Daniel M. Abrams reported in journal PLOS Biology reveals that communication signals across wildly different species tend to repeat at a nearly universal tempo of 2 Hertz. Researchers suggest this isn't a coincidence, but a biological resonance where animal brains are naturally tuned to process information most efficiently at this specific pace. This 2 Hz rule applies to social communications of animals from insects to large mammals and does not depend on the physical size of the animal. Neural circuits respond strongly to signals in the .5-4.0 Hz band. Also faster signalling is possible.

These findings provide support for the TGD inspired view of quantum biology in which the quantum coherence associated with long range gravitational and electromagnetic fields plays a key role in even astrophysical scales.

1 Introduction

I learned about a fascinating finding discussed in Neuroscience News). The popular article discusses the findings reported in the article "A widespread animal communication tempo may resonate with the receiver's brain" by Guy Amichay, Vijay Balasubramanian, and Daniel M. Abrams in journal PLOS Biology [J1].

The study reveals that communication signals across wildly different species tend to repeat at a nearly universal tempo of 2 Hertz (two beats per second). Researchers suggest this isn't a

coincidence, but a biological resonance where animal brains are naturally tuned to process information most efficiently at this specific pace. This 2 Hz rule applies to social communications of animals from insects to large mammals and does not depend on the physical size of the animal. Neural circuits respond strongly to signals in the .5-4.0 Hz band. Also faster signalling is possible. What is interesting is that most popular music clusters around 2 Hz. This is remarkable since animal communications can look wildly different flashing lights, chirping calls, croaking songs and elaborate dances. It should be noticed that audible frequencies in the case of humans are above 20 Hz.

These findings provide support for the TGD inspired view of quantum biology in which the quantum coherence associated with long range gravitational and electromagnetic fields plays a key role in even astrophysical scales [L6, L4, L3]. The key notions are as follows.

1. The hierarchy of effective Planck constants, including gravitational and electric Planck constants, and labelling phases of ordinary matter behaving like dark matter.

2. Field body (magnetic body) carrying these dark phases of matter as a counterpart for the classical gauge fields:

   The communications from biological body to field body and its control by field body would occur at cyclotron frequencies assignable to the monopole flux tubes. For DNA this frequency depends only slightly on the DNA sequence. For the endogenous magnetic field strength $B_{end} = .2$ Gauss explaining Blackman's findings [J2], the cyclotron frequency is 1 Hz. A hierarchy having at least 4 levels characterized by the values of B_{end} coming as octaves of .1 Gauss is suggested by the findings of [J1]. The p-adically natural octave hierarchy was originally inspired by the fact that music experience is characterized by octave equivalence.

3. The TGD based model for the genetic code based on the unique and universal icosa tetrahedral tessellation of the hyperbolic 3-space (light-cone proper time constant hyperboloid):

   At the fundamental level, the communications between animals would occur via the gravitational and electric field bodies using dark photon signals. Also other frequency ranges that .5-4 Hz involving at least 3 octaves could be involved and could give rise to fundamental biorhythms in various time scales. These communications would not be conscious at our level of the self hierarchy but would make possible remote mental interactions.

2 TGD view of the findings

One of the basic predictions of TGD inspired quantum biology is field bodies (as counterparts of Maxwellian magnetic fields), carrying phases of ordinary matter with a large value of effective Planck constant and therefore behaving like dark matter, are central in biosystems. The cyclotron frequencies in the endogenous magnetic field B_{end} associated with the magnetic body are crucial for the biocontrol and communications and for TGD inspired theory of consciousness [L10, L11].

1. Blackman [J2] proposed on the basis of his findings about the effects of ELF radiation on vertebrate brains the existence of an endogenous magnetic field $B_{end} \simeq .2$ Gauss, about 2/5 of the strength of the Earth's magnetic field. It would explain the quantal effects of ELF radiation fields in the EEG range on vertebrate brains.

2. In TGD this endogenous magnetic field is assigned to the magnetic monopole flux tubes distinguishing between the Maxwellian and TGD based views of electromagnetism. Also the octaves of B_{end} are predicted in the TGD based model for music experience [L1] leading also to a model for the genetic code in terms of bioharmony [L2, L5]. The corresponding cyclotron frequencies would come as octaves.

3. The huge value of the cyclotron energy scale proportional to $h_{eff} = h_{gr}(Earth)$ implies that the effects of ELF em fields are large and not masked by thermal noise. In the Earth's gravitational field, the value of $h_{gr}(Earth)/h$ is $\simeq 2.4 \times 10^{13}$ and implies that the energy of 10 Hz alpha frequency belongs to the energy range of visible light. The proposal is that biophotons are produced by the transformation of dark photons to ordinary photons such that energy is conserved but wavelength is reduced by factor $h/h_{gr}(Earth)$ to ordinary photons.

2.1 A model for the quantum communications in biomatter

The findings about animal communications lead to a detailed quantitative model of quantum control and commutations in biomatter.

2.2 The identification of 2 Hz frequency as a cyclotron frequency for DNA

The model for communications and control in TGD inspired quantum biology involves the cyclotron frequencies for dark ions assignable to the magnetic body of the system.

1. The cyclotron frequencies of the basic ions appearing in biomatter as cold plasma are in a key role [K1, K4, K3]:

   The cyclotron frequencies of various ions and DNA would relate to the communications from the biological body to the magnetic body and the control of the biological body by the magnetic body. Organisms, even those belonging to different species, can communicate with each other via their personal magnetic bodies and by larger, shared magnetic bodies. I have proposed this as a basic mechanism of remote mental interactions and the communications at the level of DNA could be unconscious communications giving rise to remote mental interactions.

2. The cyclotron frequencies of various biologically important ions are in EEG range for $B_{end} =$ .2 Gauss and would related to the communication of sensory information from the biological body to its magnetic body and to control of the biological body by the magnetic body. They would play a key role in neuroscience. For 10 Hz the wavelength would correspond to a scale defined by the circumference of the Earth.

3. The cyclotron frequencies of DNA strands depend rather weakly on the details of the DNA strand, since its total charge is proportional to its length and therefore to its mass [L11]. The cyclotron frequencies are predicted to be around 1 Hz for $B_{end} = .2$ Gauss, which is the strength of the endogenous magnetic field explaining the findings of Blackman.

4. The experiments suggest 2 Hz frequency and $B_{end} = .4$ Gauss. The communication frequencies belong to the range .5 Hz and 4 Hz, which makes 3 octaves. This suggests at least 3 values of B_{end} coming as octaves. Note that in the case of humans, the range of audible frequencies is about 10 octaves and ranges from 20 Hz to 20 kHz and can be assigned to cyclotron frequencies of various ions. 20 Hz would correspond for $B_{end} = .2$ Gauss and 10 Hz alpha frequency to $B_{end,min} = .1$ Gauss.

5. What is fascinating is that the sum for the masses using g/mol as a unit for base the pairs formed by A (331.2) and T (322.2) and C(347.2) and G(307.2) are the same and equal to 654.4! For the double DNA strand the base pairs would have the same cyclotron frequency so that identical frequencies would not be an approximation!

2.3 Connection with the model of nerve pulse and EEG

There is also a connection with the TGD inspired model of nerve pulse and EEG [K1, K4] [L7].

1. The membrane potential V of the cell membrane varies in the range which corresponds to Coulomb energy range 0.02-.2 eV. For neurons the range of V is 0.06-0.08 eV. The thermal energy per particle at room temperature is in the range .025-.026 eV. For $\hbar_{gr,E} = GMm_p/\beta_0$ and for $f_c = .5$ Hz, the energy $E = h_{gr}f_c$ of a dark photon would be be would be .02 eV.

   For ordinary cells the lower bound for V corresponds to .5 Hz and the lowest octave in the hierarchy suggested by the findings of [J1]. For neurons the lower bound corresponds to $f_c = 1$ Hz and second octave. The upper bound .08 eV for the neuronal V corresponds to cyclotron energy E_c for $f_c = 2$ Hz frequency. To understand the range of the ordinary membrane potential, the inclusion of the highest octave .16-.32 eV is required.

Interestingly, the frequency for the lower bound .06 eV for the neuronal V corresponds to the quint of the frequency for .04 eV. Quint cycle is essential for the model of the genetic code based on icosa tetrahedral tessellation of hyperbolic 3-space [L2, L5].

2. One can wonder whether the minimum of the neuronal membrane potential correlates directly with the precise value of $B_{end,min}$ and therefore with the thickness of the monopole flux tubes? If so, it would be possible to measure it from the membrane potential.

   The second option is that the membrane potential is analogous to the length of the string producing the note. Bio-harmony is defined by a Hamiltonian cycle. Icosahedron allows a large number of Hamiltonian cycles and dodecahedron a unique Hamilton cycle.

3. The cyclotron frequency 2 Hz for DNA would correspond to $B = 2 \times B_{end} \simeq .4$ Gauss, which is near the nominal value of the Earth's magnetic field. This raises questions. Could there be a hierarchy of monopole flux tubes with field strengths coming as octaves of the field strength about $B_{end,min} \sim .1$ Gauss? This hierarchy would have at least 3 levels. Do the sub-octaves of B_{end} correspond to evolutionary hierarchy such that B_{end} is reduced by factor 1/2 as a higher evolutionary level with a longer cyclotron time scale emerges? Could genes be classified according to what octave they correspond in the hierarchy?

2.4 Connection with the bioharmony model of the genetic code

One can consider the analog of membrane potential as a note in the framework of bioharmony [K2] [L2, L5]. The model for the bioharmony allows us to consider two options, realized in terms of icosahedral and dodecahedral Hamiltonian cycles. Icosahedron allows a large number of Hamiltonian cycles. For the dodecahedron the cycle is unique. If the Pythagorean scale is assume, the change of the frequency between subsequent points of the cycle is quint (scaling of frequency by factor 3/2) and Octave Equivalence is assume to hold true for the sensory experience.

1. Yhe icosahedral scale allows the realization of the genetic code [L5, L2, L9, L12, L13] and different cycles are identified as correlates for molecular moods.

   Could the membrane potential be quantized and allow the realization of either the icosahedral 12-note scale of the Western music or of the dodecahedral 20-note scale appearing in the Eastern music [L2]?

   Neuronal membrane potential is indeed quantized with miniature potential appearing as a unit ΔV in the range $.4 - .5$ meV.

2. The ratio $\Delta V/V$ would be about $1/k$, $k = 12$ *resp.* $k = 20$ for these two scales. The 12-note scale gives too large a value of $\Delta V/V$. The 20-note scale with $\Delta V/V = 1/20$ for $\Delta V = .5$ meV would require $V = .01eV$ and therefore one more sub-octave with $f = .025$ Hz. If Cooper pairs are charge carriers, as proposed in the model for nerve pulse and EEG [L7], their Coulomb energies $E = 2eV$ would be very near to the thermal energy per particle at room temperature so that this might work.

2.5 Does the model of bioharmony explain the major and minor scales?

The details of the bioharmony model have remained somewhat unclear. Bioharmony model [K2, L2] predicts that 64 genetic codons can be identified as 64 3-chords as faces of 3 copies of icosahedron and one tetrahedron. This structure emerges from the icosa tetrahedral tessellation (ITT) [L5, L9]. There is an intriguing correspondence with the TGD based model for the icosahedral supercluster of water molecules and the supercluster is proposed to be in 1-1 correspondence with the realization of ITT at the field body of the system in terms of dark DNA [L13]. The recent finding that animals communicated in frequency range peaked around 2 Hz discussed in this article gives additional support for the model.

There are however long standing objections against the bioharmony model. In particular, the model predicts 12-note scale and complex bio-harmonies with 64 3-chords but does it allow us to understand the simplest major and minor scales and corresponding 3-chords?

1. Quint cycle modulo octave equivalence gives the notes of 12-note scale. This scale can be deformed to well-tempered scales in which notes correspond to powers of $2^{1/12}$ modulo octave equivalence. The cycle FCGDAEH gives the notes of the major scale. $3 + 1/2$ octaves are involved. Note that the quint cycle spans the note-scale of classical guitar. Also the minor scale is obtained. What remains missing are the altered notes F♯ and G♯.

   Interestingly, the recent findings about animal communications containing frequency range .5 Hz -4 Hz and also higher frequencies are consistent with the range of 3 and 1/2 octaves.

   If the quint cycle is continued, notes which do not belong to the basic scale appear and eventually give the 12-note scale. One can say that the standard scale emerges naturally.

2. What about the icosahedral 3-chords assuming a quint cycle? The edges of a face (triangle) contained in the Hamilton cycle correspond to quints. The number of quints per triangle is $n = 0, 1, 2$. 3 quints would mean that the cycle intersects itself. Also triangles sharing no edges with the Hamilton cycle are possible. The problem is that the ccosahedral part of the bioharmony does not contain in a natural way major and minor chords containing minor third (e.g. CEG and ACE).

Could the tetrahedral part of the bioharmony come to rescue? One can consider several options for tetrahedral harmony. The basic condition is that the model gives major and minor chords. This is true if the tetrahedral scale contains edges defining minor third, major third and quint.

1. For the first option the tetrahedron does not share faces with the icosahedron and the tetrahedral Hamilton cycle is closed and corresponds to an octave. The simplest assumption is that the edges of the cycle correspond to minor thirds but one can also consider other options. 2 edges do not belong to the cycle. The notes of the 4-note cycle starting from A correspond to ACE♭F♯A. This does not allow chords containing minor third and major third.

   It seems that one must give up the ACE♭F♯A scale. The tetrahedral cycle CGEAC however satisfies the constraints: the faces contain quint CG, major third CE, and minor thirds AC and EG. The 4 tetrahedral chords are CEG(major), ACE (minor), and AGC and EAG.

2. During years I have considered many proposals for how the icosahedral and tetrahedral harmonies could be fused together. Tetrahedron has only a single Hamilton cycle. The notion of key is however essential when the scale is not the full 12-note scale, especially so when no modified notes are involved. The key distinguishes between different tetrahedral harmonies differing by transposition. The key for the tetrahedral chords could be determined by assigning the tetrahedron to a single note of icosahedral 12-note scale. Does this have a geometric interpretation? For instance, do the icosahedron and tetrahedron share a single vertex? This would allow 64 chords.

2.6 Is dodecahedral code associated with the communications of dark codons with the cell membrane?

The considerations above inspire the question whether both icosahedral and dodecahedral realizations of the music harmony and of the genetic code appear in the quantum communications in living matter and whether they are independent or correlated.

Communications by dark N-photons as analogs of Bose-Einstein condensate are essential in TGD based quantum biology. Genetic codons would define 12-note scale and icosahedral frequency triplets genes would correspond to 3N-photons. Dark proton triplets as basic units represented by a single frequency could define a 20-note dodecahedral scale.

1. Icosa tetrahedral tessellation gives rise to a universal realization of genetic code and the duals of 3 icosahedra and 1 tetrahedron involved with it would give rise to 3 dodecahedral codes and 1 tetrahedral code.

2. Cyclotron frequency triplets of dark photons associated with transitions between dark genes would define the basis of communications based on resonance mechanisms. Genes would define 3N-photons. Dodecahedral genetic code assigning frequencies to the faces of the icosahedron could in turn realize the dodecahedral Hamilton cycle defining 20-note scale. This realization could be relevant to the communications between dark genes and the cell membrane.

3. Pentagons as the faces of dodecahedron define icosahedron as its dual. Intriguingly, this has a counterpart at the level of genetic codons. The base pairs (A,T), (T,A) and (C,G),(G,G) formed contain one pentagonal aromatic cycle so that the base pairs define 4 different pentagons. Therefore the dark codons realized as frequency triplets would correspond also to triplets of pentagons.

   Each pentagon would correspond to a cyclotron frequency associated with the proton of dark codon. 3-chords defining harmony and notes defining the melody are key elements of music and the TGD inspired view of genetic code is ineed based the notion of bioharmony realized in terms of 3-chords.

4. This suggests that genetic codons correspond to the 20 triplets of cyclotron frequencies as chords assignable to triangular icosahedral faces and that the 20 dodecahedron vertices correspond to the cyclotron frequencies assignable to these codons as units. There would be two levels: the triplets formed by the vertices of triangles with different cyclotron frequencies and the triangles as a whole characterized by a single frequency.

5. For h_{gr} the dark cyclotron energies do not depend on the small mass at all. This reflects the Equivalence Principle. For a given value of B_{end} they are the same for all dark ions and DNA codons. This indepence is absolutely essential for the possibility of communication.

   The strengths of the endogenous magnetic fields B_{end} associated with dark protons must define 12-note scale modulo octave equivalence. For the Pythagorean scale, the values of B_{end} would increase by factor 3/2 (quint cycle) along the icosahedral Hamilton cycle. For the well-tempered scale this is not quite true and the notes come as powers of $2^{1/12}$ but also now the quint cycle makes sense.

6. The values of the B_{end} assignable to the dodecahedral monopole flux tubes associated with the entire codon should define a 20-note scale and correspond to the unique Hamilton cycle for dodecahedron.

   One can imagine that the 3 monopole flux tubes assignable to an active codon fuse together to a single flux tube with codon specific cyclotron frequency equal to the sum of the 3 cyclotron frequencies for the letters. If so, one would have $B_{end}(codon) = \sum_{i=1}^{3} B_{end}(i)$ for the codon. The values of $B_{end}(codon)$ and $f_c(codon) = \sum_{i=1}^{3} f_c(i)$ would be determined by the icosa tetrahedral Hamilton cycle and therefore depend on it.

7. Gene would be rather literally a piece of music. Dodecahedral frequencies would define the melody and icosahedral frequency triples would determine the chords. The icosa tetrahedral realization of the genetic code would also determine the dodecahedral frequencies.

2.7 What about plants and other biorhythms?

The experimental findings relate to communications between animals. What about plants and other life forms? Also plant DNA is characterized by cyclotron frequencies proportional to the corresponding value of B_{end}. Are the communications present but is the scale of B_{end} different so that the communications occur at higher or lower frequencies. Plants can be said to have motor actions but they take place rather slowly. Could this mean that the value range for B_{end} for plants is considerably lower than for animals so that the cyclotron frequencies are considerably lower for plants. Or putting it more generally, could the much slower biorhythms possessed also by animals be assigned to DNA and smaller values of B_{end}?

1. Besides the gravitational magnetic body of the Earth, also the solar magnetic body is involved. The solar gravitational Planck constant would give cyclotron energies scaled up by the

ratio of the gravitational Planck constants $x \equiv \hbar_{gr}(S)/\hbar_{gr}(E) = (\beta_0(E)/\beta_0(S)) \times M_S/M_E \simeq 2^{11} \times 3 \times 10^5 \simeq 6 \times 10^8$ of the Sun and Earth. The cyclotron energies would be huge for $B_{end} = .2$ Gauss. For 1 Hz cyclotron frequency, these energies would be of the order of 100 MeV. This does not make sense.

2. Could the strength of the endogenous magnetic field at the solar magnetic body be the strength of the solar magnetic field at Earth, which is about 5 nT? The cyclotron time scale 1 s would be scaled up by a factor of $(1/x) \times B_{end}/B_S$ to ~ 11 hours. The longest cyclotron time scale of .5 seconds would scale up to 22 hours, not far from the length of the day. The cyclotron energy scale would be scaled up by the ratio $xB_S/B_{end} \simeq 1.3 \times 10^5$. $\hbar_{gr,E}/h \simeq 2.4 \times 10^{13}$ and give cyclotron energy of order 10 keV belonging to the upper boundary of the energy range [.1,10] keV of the X ray spectrum.

3. Another option is that cyclotron energies are not changed and therefore belong to the range of biophoton energies. This requires that the magnetic field strengths are scaled down by $1/x = (\beta_0(Sun)/\beta_0(Earth) \simeq 1.7 \times 10^{-9}$. The cyclotron period range [.25,2] s would scale up to about the range [4.7,37.4] years. Interestingly, the age after which the children have memories is about 4 years: could solar gravitational magnetic body be involved with long term memories? The upper bound brings in human lifetime B_{end} would be scaled down to 3.5×10^{-14} Tesla. The magnetic fields of EEG in the brain have strengths of the order of 10^{-14} Tesla.

It is interesting to look for the situation in the case of Milky Way.

1. The strength of the galactic magnetic field B_G in the interstellar space in the vicinity of the Earth is surprisingly strong, in the range $5 - 6$ nT, and essentially the same as the strength of the solar magnetic field estimated to be 5 nT so that the cyclotron period would be about 22 hours and within experimental uncertainties consistent with 24 hours.

   The mass of the Milky Way is $1.5 \times 10^{12} M_S = 4.5 \times 10^{17} M_E$. For $\beta_0(G) \simeq 1$ and $B_{end,G} = 2/5 \times B_G$, the estimate for the galactic cyclotron energy $E_c(G) = M_G/M_E \times B_{G,end}/B_{end} \sim 98$ GeV would correspond to weak boson mass scale. The mass $m_p(89) = 512 m_p = 512 GeV$ of the proton of M_{89} hadron physics. Recall that the TGD based model of the Sun [L8] assumes that the monopole flux tubes from the galactic nucleus feed M_{89} nuclei to the surface of the Sun, where they would transform to ordinary nuclei and produce solar energy and solar wind.

2. It is instructive to compare the radii of the flux tubes for the magnetic fields of the Earth, Sun and Milky Way by using $\hbar_{gr}$ as a unit of the magnetic flux and assuming unit flux. For the Earth, the ordinary Planck constant gives the estimate of $r = 5\mu$m for the flux tube radius. The estimate for the flux tube radius using $\hbar_{gr}(E)$ as a unit of flux, scales r by $\sqrt{h_{gr}(E)/h}$ giving $r_E \sim 5$ m.

   For the Sun, a similar estimate for $\hbar_{gr}(S)$ gives $r_S = \sqrt{x} r_E$, $x = (M_S/M_E) \times (1/\beta_0(S)) \times (B_S/B_E)$. This would give $r_S \sim 5 \times 10^4$ m to be compared with radius $R_E = 6378$ km of the Earth .

   For the Milky Way with $\beta_0(G) = 1$, the flux tube radius for $\hbar_{gr}(G)$ would be $r_G = \sqrt{y} r_S(G)$, $y = \beta_0(S) \times (M_G/M_S) \sim 7.5 \times 10^8$ giving $r_G \sim 1.4 \times 10^8$ m to be compared with the solar radius $R_S \sim 7 \times 10^8$ m.

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