Spectroscopy of Consciousness

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Abstract TGD based quantum measurement theory predicts that each quantum jump involves a localization in zero modes giving rise to ordinary quantum measurement followed by a state preparation by self measurements leading to an unentangled product state. The sequence of quantum jumps defines a statistical ensemble and this suggests strongly a connection between the theory of qualia and thermodynamics. Sensory qualia can be divided to purely geometric ones represented by the average increments of zero modes (quantum measurement) and to non-geometric ones represented by average increments of quantum numbers (state preparation). Emotional qualia can be assigned to the entropic gradients associated with quantum jump sequence. The hypothesis about manysheeted ionic flow equilibrium involving superconducting magnetic flux tubes explains the strange effects of ELF em fields on living matter and the observations challenging the notions of ionic pumps and channels. Together with the p-adic length scale hypothesis it leads to the notion of spectroscopy of consciousness explaining the resonance frequencies of EEG and correlating EEG bands and brain structures with the structure of the periodic table.
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1 TGD Inspired Theory of Consciousness very Briefly

TGD inspired theory of consciousness allows to construct a general model of conscious experiences based on some very general principles.

1. Quantum jump between quantum histories as moment of consciousness and the notion of self

The identification of quantum jump between quantum histories as moment of consciousness defines microtemporal theory of consciousness whereas the notions of self and self hierarchy allow to understand macroscopic aspects of consciousness absolutely essential for brain consciousness (see the chapter "Matter, Mind, Quantum" of [11]). Self is identified as a subsystem effectively behaving like its own subuniverse quantum mechanically (see the chapter "Self and Binding" of [11]). Physically this means that self is a subsystem able to remain un-entangled during subsequent quantum jumps. Self property is made possible by the decomposition of spacetime into

p-adic and real regions which cannot entangle with each other. Simple assumptions about how the contents of consciousness of self are determined allow to understand the basic structure of conscious experience at general level.

The localization in configuration space zero modes (non-quantum fluctuating degrees of freedom) occurring in each quantum jump implies that the world of conscious experience is classical and standard quantum measurement theory follows as a consequence. Also self measurements are possible and each localization in zero modes is followed by a cascade of self measurements leading to a completely unentangled product state: this is nothing but TGD counterpart of the state preparation process which is also part of quantum measurement theory. Self measurements are governed by Negentropy Maximization Principle (see the chapter "Negentropy Maximization Principle" of [11]). In p-adic context NMP is the basic variational principle of cognition.

2. p-Adic physics as physics of cognition, intention, and anticipation

TGD spacetime decomposes into regions obeying real and p-adic topologies labelled by primes $p = 2, 3, 5, ...$ (p-adic number fields can be regarded as completions of rationals). p-Adic regions obey the same field equations as the real regions but are characterized by p-adic non-determinism since the functions having vanishing p-adic derivative are pseudo constants which are piecewise constant functions. Pseudo constant depends on a finite number of positive pinary digits of its arguments. This means that p-adic spacetime regions are obtained by glueing together regions for which integration constants are genuine constants. The natural interpretation of the p-adic regions is as cognitive representations of real physics. The freedom of imagination is due to the p-adic non-determinism. p-Adic regions perform mimicry and make possible for the Universe to form cognitive representations about itself. In this vision real/p-adic mindlike spacetime sheets are interpreted as geometric correlates of sensory/imagined experiences. p-Adic regions provide also geometric correlates for intentionality. Also anticipatory systems [5] might find a fundamental description in terms of p-adic spacetime sheets.

3. New view about time

The understanding of the relationship between subjective and geometric time leads to the notion of psychological time involving in an an essential manner the new view about spacetime, in particular the idea about mindlike spacetime sheet (defined as spacetime sheet having finite time-duration) as a geometric correlate of self (see the chapter "Time and Consciousness" of [11]). One can understand psychological time as temporal center of mass coordinate for the cognitive spacetime sheet. The arrow of psychological time can be understood as resulting from a drift towards the geometric future. The simplest guess is that the average increment of the geometric time per quantum jump is given by $\Delta t = k\tau$, where k is a numerical constant and τ some fundamental time scale, most naturally of the order of CP_2 time τ_{CP_2} about 10^4 Planck times.

The notion of psychological time forces to view the entire manysheeted spacetime

surface as a living system so that the standard notion of linear time is illusory and reflects the restricted information content of our conscious experience rather than fundamental 4-dimensional reality. The paradigm of 4-dimensional brain provides completely new understanding of the long term memory: no memory storage mechanisms are needed and one avoids the basic difficulties of neural net models. There are two kinds of memories, geometric and subjective, as also two kinds of causalities.

4. Selves self-organize

Subjective time development by quantum jumps implies quantum self-organization which can be regarded as a sequence of quantum jumps between quantum histories (see the chapter "Quantum Theory of Self-Organization" of [11]). This evolution corresponds to a sequence of macroscopic spacetime surfaces associated with the final state quantum histories. Quantum jumps imply dissipation at fundamental level. Dissipation serves as a Darwinian selector of self-organization patterns, which can represent both genes and memes. In particular, one can understand how habits, skills and behavioural patterns are gradually learned.

5. Self hierarchy

The notion of self hierarchy, starting from elementary particle level and having entire Universe at the top, is a highly nontrivial prediction of TGD inspired theory of consciousness. Self hierarchy is very much analogous to the hierarchy of subprograms of a computer program and defines a hierarchy of increasingly abstract experiences. Self hierarchy allows to understand computational aspects of brain although connectionistic picture realized as quantum association network seems to work at various levels of the hierarchy (see the chapter "Quantum Model for Intelligent Systems" of [11]). Topological field quanta of em fields are an part of self hierarchy and this force to give up the view that consciousness is brain centered phenomenon (wavelength of 10 Hz EEG photon has size scale of Earth). Self hierarchy is also crucial for the model of sensory qualia.

6. Self as a statistical ensemble and qualia

The notion of self means possible fundamental identification of two kinds of ensembles: subjectotemporal ensemble defined by the quantum jumps occurred after the last 'wake-up' and spatial ensembles defined by subselves of self defining mental images of self as statistical averages over experiences of subsubselves. This leads to the hypothesis that qualia correspond to average increments of quantum numbers and zero modes in quantum jumps. The sharpness of given quale is determined by the entropy of the distribution for the quantum number increments of given type. At the statistical level qualia correspond to average rates of the change of quantum numbers and zero modes. The rates of change for entropy type variables associated with subselves are assumed to define emotional qualia. This picture is consistent with the assignment of qualia to quantum phase transitions.

2 Biological Realization of self Hierarchy

Self hierarchy has a geometric correlate the hierarchy of spacetime sheets.

1. Massless extremals

The so called massless extremals (MEs) (see the chapter "Quantum Antenna Hypothesis" of [11] and the chapters "Quantum Model of EEG and Nerve Pulse", "General Theory of Qualia", and "Spectroscopy of Consciousness" of [12]) are excellent candidates for mindlike spacetime sheets since the vacuum current associated with ME has arbitrary time dependence and is ideal for coding sensory data representing passive aspects of consciousness. The free part of ME gauge field in turn has interpretation as a classical correlate for the active aspects of ME consciousness. The fact that classical spacetimes are field theoretic counterparts of Bohr orbits, suggests that classical em field decomposes into MEs when classical decoherence occurs. MEs provide a mechanism of long term memory and the notion of MEs leads to the idea about brain as a sensory and motor organ of higher level selves and to a rather detailed view about the general organization of brain.

By general coordinate invariance the lightlike M^4_+ projections of the lightlike boundaries of MEs act as quantum holograms and can be identified as universal (but probably not the only) geometric correlates of selves. The lightlike vacuum currents are optimal for coding information and make MEs dynamical holograms in classical sense.

By Uncertainty Principle ELF MEs correspond to topological field quanta with size of Earth. It became clear already before the realization of supercanonical representations that MEs could correspond to higher level selves (see the chapter "Genes and Memes" of [12]) living in symbiosis with biological life forms and responsible fo the cultural aspects of human consciousness. This is in accordance with the idea that the flux tubes of Earth's magnetic and Z^0 fields serve as templates for the formation of biostructures. Contrary to the Newtonian intuition, the only sensical view seems to be that we ourselves correspond to lifeforms of electromagnetic size not smaller than Earth size: the illusory identification of 'me' with brain is created by the erraneous identification of self with the contents of sensory experience. This view stimulates also rather concrete ideas about physical death and life after physical death (see the chapters "Quantum model for sensory representations" and "Biological realization of self hierarchy" of [11] and the chapters "General Theory of Qualia" and "Spectroscopy of Consciousness" of [12]).

2. Hierarchy of magnetic superconductors

The empirical results [2, 4] about the effects of oscillating em fields on brain suggest that cyclotron frequencies, and more generally magnetic transition frequencies, of biologically important ions in the magnetic field of Earth correspond to important oscillation frequencies of Josephson currents and MEs. Also the magnetic transition frequencies of electronic Cooper pairs seem to be important as also Z^0 magnetic transition frequencies of neutrino and various Z^0 ions, which can be

electromagnetically neutral atoms and even molecules.

Second empirical ingredient supporting the view about hierarchy of magnetic superconductors are the puzzling observations of cell biology (for a summary see the first chapter of [13]) challenging the association of ionic channels and pumps to cell membrane. The paradoxes disappear if cell and its exterior are assumed to be in a manysheeted ionic flow equilibrium with ionic currents flowing from superconducting spacetime sheets to atomic spacetime sheets and back, so that the densities of ions at atomic spacetime sheets are controlled by the the very small densities and quantized currents of the ions at superconducting magnetic flux tube spacetime sheets and coding the information about homeostasis of biomatter (see the chapter "Biosystems as superconductors" of [11]). Also a reason why for liquid crystal and electret properties of biomatter emerges and one can understand the function of electric circuitry associated with body [1].

3. How MEs interact with magnetic superconductors

MEs induce super currents in superconducting magnetic circuits by magnetic induction mechanism, serve as Josephson junctions between magnetic flux tubes, and induce magnetic quantum phase transitions. MEs can generate reference waves or their phase conjugates (time reversals) acting on lower level MEs serving as dynamical holograms. The induced coherent light pattern and its phase conjugate could act as a control command and its time reversed version. Conjugate reference waves provide an extremely simple mechanism of healing by time reversal allowing the living matter to fight against second law. The notion of wave DNA [7] realized using a sequence of laser mirror like structures along DNA suggest a realization in terms of sequence of MEs and leads to a realization of genetic code as holograms (see the chapter "General Theory of Qualia" of [11]). MEs can also read DNA strand to the lightlike vacuum current by moving along it. MEs would code DNA strand/conjugate strand to a hologram/its phase conjugate in turn acting as a control command/its time reversal. ELF MEs could do the same at the level of axons: instead of DNA sequences nerve pulse patterns would be read now. Thus living matter could be regarded as a symbiosis in which MEs control superconducting magnetic flux tubes controlling ordinary matter at atomic spacetime sheets via manysheeted ionic flow equilibrium. DNA would represent the ROM of this system.

4. MEs as carriers of supercanonical and quaternion conformal representations

TGD predicts two kinds of superconformal symmetries (see chapter "TGD as a generalized number theory" of [9]). Quaternion conformal symmetries correspond to the gauge symmetries of fundamental interactions. Cosmological supercanonical symmetries act on the boundary of lightcone and are cosmological symmetries. The non-determinism of Kähler action however implies that the lightlike M_+^4 projections of lightlike boundaries of MEs take the role of the boundary of future lightcone as quantum holograms and supercanonical symmetry becomes ordinary macroscopic symmetry. Thus there is a fractal hierarchy of quantum holograms inside quantum holograms. One can identify the lightlike boundaries of MEs as geometric correlates

for selves. Also spacelike selves are very probably needed and magnetic flux tube structures could represent them. Indeed, the non-determinism of CP_2 type extremals representing elementary particles (their M_+^4 projections are random lightlike curves) makes it impossible to characterize the quantum state completely by the data on the lightlike boundaries of MEs.

Supercanonical degrees of freedom makes MEs ideal candidates for the correlates of higher level consciousness.

a) The states of supercanonical representations have gigantic almost-degeneracies broken only by non-commutativity of supercanonical and Poincare symmetries which means huge information storage capacities. Supercanonical representations can be realized in real context using Bose Einstein condensates of massless elementary particles on MEs. Supercanonical representations correspond to genuine quantum gravitational effects since wave functionals in the space of three-surfaces are involved: spacetime ceases to be a passive arena of quantum dynamics. In fact, canonical transformations of CP_2 are approximate symmetries of the theory broken only by classical gravitation. The notion of 'configuration space photon' having nontrivial dependence on configuration space degrees of freedom characterized by Hamiltonian suggests strongly itself and seems to be crucial for understanding of the visual colors.

b) Supercanonical representations have universal transition frequency spectrum given as multiples of the fundamental frequency determined by the length of ME. If one assumes that MEs have lengths given by p-adic length scale hypothesis, fundamental frequencies turn out to correspond to important resonance frequencies in EEG.

For these reasons supercanonical representations are ideal candidates for an infinite hierarchy of lifeforms associated with MEs. The great vision is that MEs and magnetic superconductors associated with the magnetic flux tube structures form a fractal hierarchy interacting with the ordinary biomatter via the classical gauge fields associated with MEs (see the chapters "General Theory of Qualia" and "Spectroscopy of Consciousness" of [12].

5. Place coding

Our qualia seem to be qualia about the virtual world formed by the representations of the external world. Geometric *'Where'* type qualia (position, orientation, velocity,..) result when sensory input from a particular position of external world wakes-up a particular part of sensory representation (place-coding): thus the position and orientation of subself inside self codes for the position and orientation of an object of the perceptive field.

a) Somatosensory pathways defining somatosensory maps of body in cortex take care of this coding automatically.

b) Frequency coding of geometric variables to a position of subself using a variable cyclotron frequency scale is a natural higher level coding of geometric data. Magnetic homeostasis should control the value of the local magnetic field of Earth to achieve the coding.

6. Where me is?

The motion of eye or head does not induce the sensation that the world is moving although the sensory image moves around the cortex. Rather, brain acts like a (possibly moving) canvas at which the sensory input is projected and monitored by an external observer. This very simple observation is a strong objection against the idea that the ultimate sensory representations reside inside brain, and leads to the view that the magnetic flux tube structures associated with the primary and secondary sensory organs define a hierarchy of sensory representations *outside(!)* brain (see the chapter "Quantum model for sensory representations" of [11]). Magnetic flux tube structures would serve as the sensory canvas to which sensory images are projected from brain, sensory organs, and possibly even neurons. MEs serve as projectors and place coding by magnetic transition frequency associated with ME wakes-up sensory subselves at various positions of magnetic flux tubes having varying thickness (and thus cyclotron frequency) and associate thus various sensory qualia and even more complex attributes to the objects of the perceptive field.

EEG MEs correspond to our level in this hierarchy of projections. The simplest possibility is that the sizes of these sensory selves are of the order of EEG ME sizes ($L(EEG) = c/f(EEG)$) and thus can be of the order of Earth size! Thus the ultimate sensory representations would be magnetic gigants in TGD and diametrical opposites of the neurophysiological dwarfs of standard neuroscience populating also TGD brain. The known strange effects of large scale perturbations of Earth's magnetic field on consciousness (say, statistics about the effects of magnetic storms in mental state and tectonic activity inducing UFO experiences) provide a rich palette of anomalies supporting this view. The conservation of magnetic flux makes magnetic flux tube structures of Earth size very stable: thus physical death presumably means only that our magnetic body redirects its attention to something more interesting. Near death experience support this view. One can also understand various paranormal phenomena easily in this framework and a concrete model for collective levels of consciousness emerges (higher level selves as analogs of multicellulars with cells being replaced by brains!).

7. Long term memories and time coding

The paradigm of 4-dimensional brain implied by TGD allows to understand long term geometric memories as *'When'* type qualia (time-coding): memories are stored in the temporal position where they were first experienced. Identification of the lightlike boundaries of MEs as selves realizes this idea concretely. MEs acting quantum holograms might make information transfer between future and past possible by quantum teleportation. To remember actively would be to send a question to the geometric past and to receive the answer. MEs representing ELF waves reflected in mirrors formed by the magnetic flux tubes provide a realization for this mechanism. This requires MEs to have length $L = cT$, where T defines the temporal distance of the memory from present. Note that sensory experiences receive usually content from single moment of the geometric time: only hypnagogic mental images form an

exception. In the p-adic case p-adic ME can also be spontaneously reflected in time direction yielding phase conjugate ME. Interestingly, our long term memories are mostly cognitive. Also passive memories communicated to us by higher level MEs are possible.

3 Qualia and Thermodynamics

The connection between thermodynamics and qualia was the real breakthrough in the development of ideas. In some sense this finding is not a news: the close connection between pressure sense and temperature sense and thermodynamics is basic facts of psychophysics. In TGD framework the contents of consciousness is determined as a statistical average over the sequence of very large number of quantum jump and this suggests strongly that qualia allow statistical description generalizing ordinary thermodynamical ensemble to the ensemble formed by the prepared states in the sequence of quantum jumps after the last 'wake-up' of self. This picture allows to see the ageing of self with respect to subjective time as an approach to thermal equilibrium.

a) Geometric qualia. There are geometric qualia corresponding to statiscal average increments of zero modes expressing the result of quantum measurement in each quantum jump. All geometric information about spacetime surface should reduce to geometric qualia. For instance, geometric data given by visual, auditory, and tactile senses should reduce to conscious information about increments of zero modes in quantum jump. Self experiences the average of the increments but the possibility of a sequence of subselves, whose experiences are not averaged, makes it possible to remember the digits of a phonenumber.

b) Non-geometric qualia. The sequence of the prepared states can be modelled as a statistical ensemble of Fock states, which suggests that thermodynamics is basically part of theory of consciousness. The ensemble of prepared states gives rise to a large number of statistical qualia. The relationship $dE = TdS - PdV + \mu dN + B \cdot dM...$ generalizes to TGD context: note however that in case of ME selves energy is replaced with the Super Virasoro generator L_0 associated with the lightcone boundary of ME. Each intensive-extensive variable pair in the differential should correspond to a non-geometric quale, which results only when there is gradient (flow) of the extensive variable in the direction of the subjective time. Supercanonical thermodynamics should obviously map ordinary thermodynamics to the level of conscious experience.

The thermodynanical expression for dE suggests a general classification of qualia to entropy related, kinestetic and chemical qualia consistent with the 'holy trinity' of existences implied by TGD.

a) Entropy related qualia. $T - S$ pair correspond 'subjective existence' and generalizes to disorder-order type, information theoretic qualia qualia about the state of self: hot-cold and pain-pleasure type experience and also more abstract experi-

ences associated with various subselves of self. These qualia are strongly emotional single-pixel holistic qualia measuring whether some kind of entropy variables associated with self is increasing or decreasing. Emotional qualia are associated with both geometric and non-geometric qualia and could correspond to emotions about state of external world (say aesthetic experiences) and about body (pain, pleasure). Peptides are often regarded as both the molecules of emotion as well as of information. Since peptides perform biocontrol as information molecules they must induce especially intense entropy gradients with respect to subjective time and thus strong emotions.

The total entropy of subself tells how sharp the mental image is. Alertness, attention and level of arousal obviously strongly correlate with the total entropy. To keep mental images sharp (to attend) is to fight against second law with help of metabolism and 7 ± 2 law for cognition expresses the maximum number of mental images which can be kept in low entropy state simultaneously.

b) Kinestetic qualia. p-V pair corresponds to the 'geometric existence' and is replaced with generalized force-generalized coordinate pairs in quantum fluctuating degrees of freedom. Generalized forces reduces to increments of Poincare, color and electroweak quantum numbers and are universal qualia accompanying all quantum phase transitions. In particular, energy increment defines timelike component of sense of force and corresponds to a key quale associated with hearing. Also $B - M$ pair gives rise to kinestetic qualia.

c) Generalized chemical qualia. $\mu - N$ pair corresponds to 'objective existence' defined by quantum histories and N is generalized to a number of particle like excitations in the Fock state resulting in the state preparation. In this case there must be a gradient of particle number associated with self with respect to subjective time, that is Bose-Einstein condensation type process for, say Cooper pairs.

i) Chemical qualia would very naturally correspond to the Bose-Einstein condensation of ions to the superconducting magnetic flux tubes. In principle, endoneous NMR and its generalizations induced by the interaction of magnetic and Z^0 magnetic fields of MEs with magnetic and Z^0 magnetic flux tube structures are possible.

ii) For super canonical qualia the number of Bose-Einstein condensed 'configuration space photons' having nontrivial dependence on configuration space degrees of freedom replaces number of molecules. Supercanonical qualia could actually reduce to visual colors and polarization quale since color $SU(3)$ and two-dimensional spin label the elements of supercanonical algebra. Also the BE condensation of the ordinary coherent light could give rise to some kind of quale: perhaps vibratory sense which can be developed to effective vision, could correspond to non-colored vision.

iii) Particle number could be also topological, say the number of join along boundaries bonds as in case of sense of touch or physical pain.

d) Boolean qualia. Super algebra contains also super generators carrying fermion number and having otherwise same quantum numbers Lie algebra generators. Depending on whether ordinary Lie-algebra generator or super generator is in ques-

tion, quale corresponds to sensory or Boolean quale (fermion number $1/0 \leftrightarrow$, 'this is true/false' sensation): thus sensory and Boolean qualia are in one-one correspondence which suggests that the contents of a Boolean statement associated with a given fermionic generator relates closely to the sensory quale represented by the corresponding bosonic generator. Thus bosons would correspond to sensory consciousness and fermions to logical mind and the structure of the super canonical and quaternion conformal algebra would relate directly to the general structure of conscious mind.

4 Nerve Pulses, EEG, and Qualia

4.1 How Nerve Pulse Patterns are Coded to Sensory Qualia?

Nerve pulse patterns generate qualia and there must be some kind of coding mechanism. Since EEG frequencies are involved temporal coding must be in question. This is in conflict with the most standard wisdom that only the rate of firing determines the content of sensory experience. There is indeed strong empirical evidence for various kind of temporal coding mechanisms: the oldest evidence comes from Benham top [3]: suitable temporal pattern of stimulation by achromatic light is able to produce color sensations.

1. Pendulum metaphor for how nerve pulse patterns induce EEG waves

ELF selves carry only multiples of fundamental frequencies and are like strings of music instrument. Nerve pulse patterns amplify ELF wave like periodic kicks of pendulum at correct half period give it large energy: thus the mechanism is extremely robust. What happens is that although pendulum is reset but continues to oscillate with same frequency: this results in the observed loss of synchrony of EEG during sensory arousal. The frequency of ELF self specialized to experience particular part of brain code for positions of brain structures. It is natural to expect that these frequencies are ordered geometrically. For instance, frequency could decrease when one moves from primary sensory areas to secondary, tertiary,... areas since lower frequencies represent longer p-adic time scales and and correspond to higher p-adic 'intelligence quotient'.

2. Stochastic resonance and coding of EEG frequencies to spike sequences

Stochastic resonance [6] is an excellent candidate for a mechanism allowing to code EEG frequences to the spike sequencies. Non-linear oscillator in double well potential is driven by a periodic force and white noise amplifies the periodic perturbation resonantly if white noise has correct intensity. At resonance phase locking occurs but resonance in the ordinary sense of the word is not in question.

Stochastic resonance has been verified for both SQUIDs and at neuronal level [6]. Stochastic resonance provides a mechanism of temporal coding and a manner to detect very weak periodic signals from a noisy background. It is however not at all obvious that excitable media, which do not allow bistable states, allow stochastic

resonance. This inspires the hypothesis that bistable stochastic resonance occurs at quantum control level. Stochastic resonance is indeed possible for superconducting circuits containing Josephson currents and could be the basic amplification mechanism for weak EEG waves in TGD framework. At stochastic resonance, each period of the oscillating Josephson current generates with a high probability a spike and EEG period is coded as a peak in the distribution for the time interval between two spikes (see the chapter "TGD based model for EEG and nerve pulse" of [12]).

3. Scaling law

The scaling law relates the size L of the sensory subself in brain or CNS and the length $L(EEG)$ of EEG ME associating with the sensory subself a point of the magnetic canvas providing the ultimate sensory representation (ME induces magnetic quantum phase transition at that point). Also the size of the magnetic flux tube structure is assumed to be of order $L(EEG)$. The scaling law reads as

$$L(EEG) = \frac{c}{f} = \frac{c}{v}L , \quad L = \lambda = \frac{v}{f} .$$

f denotes EEG frequency and v the apparent phase velocity v of EEG wave, which actually corresponds to the velocity of motion for EEG ME along along axon and is equal to the nerve pulse velocity. L is identified as the apparent wavelength λ of EEG wave and cannot be larger than brain size. The known ranges of variation for v ($3 - 7$ Hz on surface of scalp [8]) and λ (below 30 cm) imply that EEG frequencies representing our conscious experiences should be in the range $8 - 40$ Hz during ordinary wake-up consciousness. During meditative states lower frequencies represent experiences conscious-to-us.

Once the value of the cyclotron frequency is fixed, scaling law fixes the size L of the generalized sensory organ from which the radial magnetic flux tubes defining the sensory canvas of size of order $L(EEG)$ emanate. Interestingly, the sizes of lense and retina correspond to proton and deuteron cyclotron frequencies and thus to the lowest levels of nuclear magnetic consciousness. The length scale of 5 microns corresponds to the electronic cyclotron consciousness: this suggests that already neurons have sensory representations based on magnetic flux tube structures with size of order 10^4 meters.

4.2 Periodic Table, Supercanonical Algebras, EEG Bands and the Areas of Sensory Cortex

Music metaphor suggests that cyclotron frequency scale as such should not have much significance for magnetic qualia. The ratio of Larmor frequency and cyclotron frequency could however matter. For instance, ions with vanishing electronic angular momentum J_e have much lower Larmor frequencies and spin qualia must be different for ions having $J_e = 0$ and $J_e > 0$. As long as ions behave as magnetic rigid bodies in quantum jumps, the electronic structure should not however affect the magnetic qualia.

1. What periods of the periodic table have to do with the hierarchy of sensory areas?

The cyclotron frequencies associated with singly ionized atoms can be obtained by the formula

$$f = \frac{A}{20} \times f(Ca_{++}) \quad f(Ca_{++}) \simeq 15 \; Hz \; . \tag{1}$$

Here the strength of Earth's magnetic field is assumed to be .5 Gauss $= 5 \times 10^{-5}$ Tesla. A denotes atomic weight. Frequencies vary roughly in the range $1.5 - 90$ Hz such that lowest periods of the periodic correspond to gamma and beta frequencies and highest periods to delta frequencies. Astonishingly, the periods of the periodic table turn out to correspond to various bands of EEG as also the table below demonstrates (see the chapter "Spectroscopy of consciousness" of [12]).

The independence of the magnetic quale on frequency scale inspires the hypothesis that the five periods of the periodic table define a hierarchy of magnetic qualia such that higher periods contain the copies of the lower periods. An interesting hypothesis is that periods also correlate with the five layers of the sensory cortex (primary, secondary, tertiary, etc... sensory cortices). The number of frequencies conscious-to-us (or some-one) increases when one moves from Helium period to Xenon period. The sensory acuity determined by negentropic resources obviously improves when the number of conscious-to-us harmonics playable by quale instrument increases.

2. Supercanonical qualia correspond to important resonance frequencies of EEG and to the hierarchy of sensory areas

Supercanonical (presumably visual) qualia can be classified the properties of $X^2 \times CP_2$ Hamiltonians, where X^2 is the lightlike coordinate=constant section of the M_+^4 projection of the lightlike boundary of ME. That is, by the color representation and value of the component of angular momentum associated with the function of X^2 coordinates. If the classical gauge fields associated with ELF MEs with lengths given by p-adic length scale hypothesis induce the quantum transitions of massless states associated with MEs, transition frequencies come as harmonics of the fundamental frequency $f(n, k)$ associated with SCA

$$f(n, k) = 1/T_n(k) = \frac{c}{L_n(k)} = 2^{-\frac{nk}{2}+127} \times 10 \; Hz \; ,$$

where $T_n(k)$ is the n-ary p-adic time scale associated with p-adic prime $p \simeq 2^k$ and constant of Nature. $f(2, 127) = 10$ Hz serves as a natural reference frequency and defines a fundamental rhytm in biosystems. All these frequencies are positive or negative octaves of $f(2, 127)$ or $\sqrt{2} f(2, 127)$ and should have anomalous effects on biosystem also in radiowave, infrared, visible and ultraviolet ranges.

The primary, secondary, etc... areas of neocortex seem to correspond to definite Super Virasoro ELF selves containing at least the p-adic length scales $L_2(2^5)$,

$L(251)$, $L_2(127)$, $L(2^8)$, $L(257)$, $L_2(131)$, ... with fundamental Super Virasoro frequencies $f(k,n)$ equal to 40 Hz, 28.2 Hz, 10 Hz, 5.0 Hz, 3.5 Hz, .63 Hz,... Note that these fundamental frequencies correspond to gamma, beta, alpha, theta and delta bands. Even to my nonprofessional best knowledge most of these frequencies and their harmonics are important resonance frequencies in EEG so that EEG provides direct support for the supercanonical (assuming p-adic quantization of the preferred length of ME), which represent the most advanced mathematical constructs of unified quantum field theories usually believed to have direct implications only in Planck length scales.

The $v = Lf$ scaling law described earlier implies the existence of a mapping

$$L(k(bio)) \rightarrow L(k(ELF))$$

between biological length scales $L(k(bio))$ and higher level length scales $L(k(ELF))$. The mapping means that ELF self characterized by $k(ELF)$ receives sensory input from corresponding biological length scale $L(k(bio))$ and presumably has corresponding biological selves as subselves.

The table below provides a concise summary of the proposed correspondences. The length scale $L_3(83)$ corresponds to $f(1,0) = 56$ Hz contained also in the EEG range and is not given in the table. For instance, the bioselves at length range 8-16 cm corresponding to the size of brain hemisphere and to tertiary sensory areas are scanned by ELF selves at theta frequencies.

k(bio)	191	193	97_2	197	199	101_2 (67_3)
L(k(bio))/cm	1	2	2.8	8	16	45 (32)
k(ELF)	2_2^5	251	127_2	$2^8 = 256$	257	131_2
f(k,n)/Hz	40.0	28.2	10.0	5.0	3.5	.63
sensory area	I	I	II	III	IV	V
EEG band	gamma	beta	alpha	theta	delta	delta
period	He	Ne	Ar	Kr	Xe	

Table 1. The correspondence between biological and ELF length scales suggested by $v = L(k)f$ relationship assigning to the 'biological' length scale $L(k(bio))$ (not larger than body size) ELF frequency $f(k,n)$ and corresponding higher level p-adic length scale, which is of order of Earth circumference for 8 Hz EEG frequency. Also the proposed assignments of the sensory areas of neocortex to these length scales are given. The subscript associated with the exponent k tells whether the scale is secondary or tertiary in case that it is not primary (one has $p \simeq 2^k$ by p-adic length scale hypothesis).

antenna hypothesis and led to the realization of the connection with the spectroscopy of consciousness.

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