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The recent view of TGD inspired theory of consciousness

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Contents

Abstract

This article gives a summary of TGD inspired theory of consciousness as it is towards the end of 2025. In the TGD framework, it is not possible to discuss consciousness without the TGD view of space-time and quantum. Also the applications to quantum biology and neuroscience have been essential in the development of ideas. The basic inspiration has come from the deep philosophical problems of recent day physics and philosophy of consciousness. The TGD view of consciousness can be seen as a generalization of quantum measurement theory: the observer as an outsider becomes a part of the system.

The basic new element is zero energy ontology (ZEO) as a new quantum ontology forced by the new view of space-time as 4-surfaces analogous to Bohr orbits of particles as 3-D surfaces. The dynamics of the classical space-time obeys holography = holomorphy principle. The failure of a strict classical determinism provides geometric correlates of intention and cognition. ZEO allows us to solve the basic problem of quantum measurement theory, allows free will, and provides a new view of the relation between geometric time and subjective time.

There would be two different kinds of existence. Physical existence is identified as the mathematical existence of quantum states: one can speak of quantum Platonia. Conscious existence is identified as quantum jumps between them. The classical non-determinism gives rise to quantum jumps giving rise to conscious entities, selves, and the ordinary quantum jumps are predicted to change the arrow of time. This means death and reincarnation of self with an opposite arrow of time.

Also the number theoretic vision of TGD is central. A key implication of the number theoretic vision is a hierarchy of Planck constants h_{eff} making possible quantum coherence in arbitrarily long scales crucial for the coherence of living matter. p-Adic length scale hierarchy is the second number theoretic prediction. The applications to quantum biology and neuroscience rely on these hierarchies.

In the sequel, the key notions and ideas of TGD, especially those relevant to consciousness and quantum biology, and the recent view of TGD inspired theory of consciousness are summarized.

Key words: Consciousness, geometry, number theory, holography, holomorphy, "world of classical worlds", quantum Platonia, failure of classical non-determinism, state function reduction, cognitive measurement.

1 Introduction

Topological GeometroDynamics (TGD) [L29, L30] was born as a proposal for a unified theory of fundamental interactions. The basic idea came in 1977 and my thesis was published in 1982. Around 1995 I started a systematical development of TGD inspired theory of consciousness and quantum biology (for a material about TGD see this).

1.1 What TGD inspired theory of consciousness is?

TGD inspired theory of consciousness solves the problem of free will. Free will is in conflict with the determinism of classical physics and with the statistical determinism of quantum physics. Also the basic problem of quantum measurement theory is due to the conflict between non-determinism of state function reduction (SFR) and determinism of unitary time evolution. The logical steps of the proposed solution are as follows.

1.1.1 The new view about the space-time

Consider first the new vision about space-time.

1. In TGD space-time of general relativity is replaced with a 4-D space-time surface X^4 in 8-D embedding space $H = M^4 \times CP_2$ (see the illustration) [L29, L30]. This

solves the conflict of general relativity with classical conservation laws: since the M^4 factor of H realizes Poincare invariance.

2. The realization of general coordinate invariance requires holography since path integral approach solving it formally does not allow a renormalizable quantum theory. One must be able to assign to a given 3-surface as analog of a particle a 4-surface as its "orbit" obeying holography.

   Holography = holomorphy (H-H) principle allows this. [L24, L31, L26]. By Holography the space-time surface is a minimal surface X^4 irrespective of the classical action principle. X^4 is analogous to a 4-D Bohr orbit of a particle identified as 3-surface. It is nowever not strictly deterministic: this is true already for 2-D minimal surfaces spanned by frames.

   This forces us to take the Bohr orbits as basic objects instead of 3-surfaces. This gives rise to zero energy ontology (ZEO) [K6] [L9, L18].

3. Causal diamonds $CD = cd \times CP_2$, where cd is the intersection of future and past directed light-cones, are a key aspect of ZEO [L19] (see this). cd is a counterpart for quantization volume and analogous to cosmology: big bang followed by a big crunch. cds appear with all size scales and define a fractal hierarchy. This predicts Russian doll cosmology with CDs within CDs. Each $sub - CD$ carries a sub-cosmology.

   CD, or rather the parts of space-time surface, contained inside CD, defines the 4-D analog of a perceptive field.

1.1.2 The new view about quantum

Consider next the new quantum ontology.

1. Quantum states correspond to wave functions in the space of Bohr orbits ("world of classical worlds" (WCW), see the illustration) and quantum jump occurring in state function reduction occurs between these states.

   Hence TGD could be seen as a generalization of wave mechanics by replacing point-like particles, not with 3-surfaces, but with their Bohr orbits. Classical field equations and the analog of Schrödinger equation are not violated and the non-determinism of state function reduction (SFR) is not in violation with classical field equations. This leads to zero energy ontology (ZEO), which solves the quantum measurement problem [L9] [K6].

2. The slight failure of classical determinism, predicted by holography = holomorphy vision (H-H) [L26], forces to replace the sequence of repeated quantum measurements, having no effect in standard quantum theory (Zeno effect), with a sequence of "small" SFRs (SSFRs) in which the observables assignable with the discrete degrees of freedom assignable to the classical non-determinism, interpreted in terms of cognition, are measured. This sequence of self measurements defines a conscious entity, self. Subjective time corresponds to a sequence of SSFRs.

3. The ZEO assigns to the opposite boundaries of CD 3-D many-fermion states. Holography requires that the 3-surfaces defining the holographic data at the passive boundary of the CD are not affected in the cognitive measurements.

   This is achieved in quantum sense, if the cognitive measurements induce only a scaling of the CD mapping the passive boundary to itself and the wave function in

WCW and 3-D fermionic states are invariant under these scalings: this corresponds to conformal invariance.

These scalings change the size of the CD and the distance between the tips defines geometric time, which increases in a statistical sense in the sequence of SSFRs defining subjective time. Therefore subjective time and geometric time correlate but are not identical,

One can choose either boundary of the CD as a passive boundary and these choices correspond to opposite arrows of geometric time.

4. What about the TGD counterparts of the ordinary quantum measurements in which a system measures observables of another system (self and environment). They would correspond to "big" SFRs (BSFRs) reducing entanglement with the environment and possibly inducing sensory perceptions.

   The proposal is that in BSFRs the arrow of time changes (see the illustration). The sequence of SSFRs ends, the self dies, and reincarnates with an opposite arrow of geometric time (to be distinguished from the subjective time). Falling asleep and biological death are familiar examples of BSFR.

5. This view has several implications.

   (a) The basic paradox of measurement theory is solved in ZEO. Wave functions in the space of slightly non-deterministic 4-D Bohr orbits for particles as 3-surfaces are crucial elements: there is no need to violate classical field equations in the SFRs. Classical causality and the causality of free will are not in conflict since SFR does not force violation of classical field equations.

   (b) There are two times and two causalities: geometric time and subjective time, causality of field equations and causality of free will. They correlate but are not identifiable.

   (c) ZEO enables memory. Basic objects are 4-D Bohr orbits and memory locations can be identified as the 3-D loci of classical non-determinism. Memory recall reduces to a communication with the locus of the non-determinism in the geometric past.

1.2 What phenomena TGD inspired theory of consciousness explains that materialism fails to explain?

1. Free will: Free will ceases to be a mystery and is not anymore in conflict with the laws of physics.

2. Life: TGD also predicts a hierarchy of Planck constants h_{eff} meaning the possibility of quantum coherence in arbitrarily long scales. This quantum coherence at the field body of the system as a TGD analog for its classical em fields, induces the coherence of the ordinary biomatter, which is difficult to understand in the standard biology. The universality of quantum coherence together with the fractality of the TGD Universe suggests that consciousness and life are universal phenomena.

3. Death: BSFR gives rise to a death of self as a sequence of SSFRs. Death in this sense would be universal and take place on all scales. Death means reincarnation with an opposite arrow of geometric time. A sequence of reincarnations with a given arrow of geometric time is predicted. [L11].

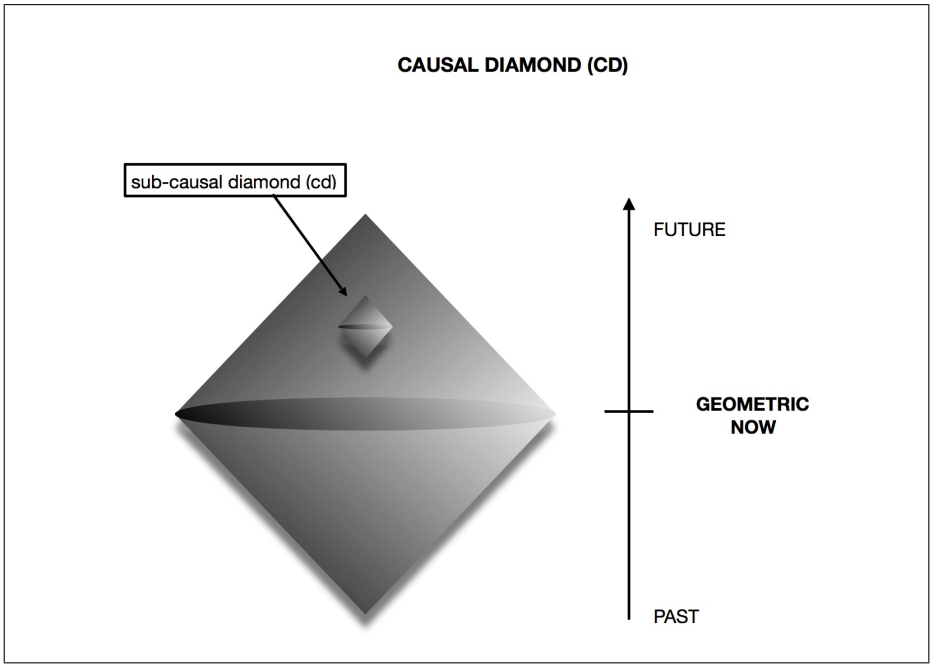

Figure 1: Causal diamond.

4. Evolution: The value of effective Planck constant h_{eff} is a measure for the algebraic complexity of the space-time surface and serves as a kind of IQ predicted to increase during evolution as an increase of complexity (see the illustration). [L8, L13, L16]. It is natural to assign a value of effective Planck constant to classical gravitational and electric fields. The values of $\hbar_{gr}$ and $\hbar_{em}$ can be very large and characterize interacting particle pairs connected by monopole flux tubes (see the illustration) . [L8, L13, L16].

5. Basic aspects of conscious experience:

   (a) The slight non-determinism of the classical dynamics, inducing similar non-determinism in fermionic degrees of freedom, predicts the presence of discrete degrees of freedom assignable to the space-time surface: cognitive/internal degrees of freedom (IDF) might be the proper term. Intention can be also assigned to these degrees of freedom.

   IDF could be responsible for cognitive consciousness. IDF can entangle with the ordinary physical degrees of freedom (ODF) associated with the system itself or with another system. Also the entanglement between the IDF of two separate systems is possible.

   (b) Quantum measurements reducing these entanglements provide a model for sensory perception and motor action [L4] and IDF-ODF entanglement provides a model for various exotic phenomena of consciousness such as telepathy, psychokinesis, and hypnosis. Also intentions and intentional actions can be understood in terms of IDF-ODF coupling.

   (c) I have also discussed TGD based models of sensory qualia [K2] as related to the measurements of ordinary observables and proposed that emotions might be sensory qualia at the level of magnetic/field bodies. IDF-ODF entanglement could assign cognitive representations to the sensory perceptions.

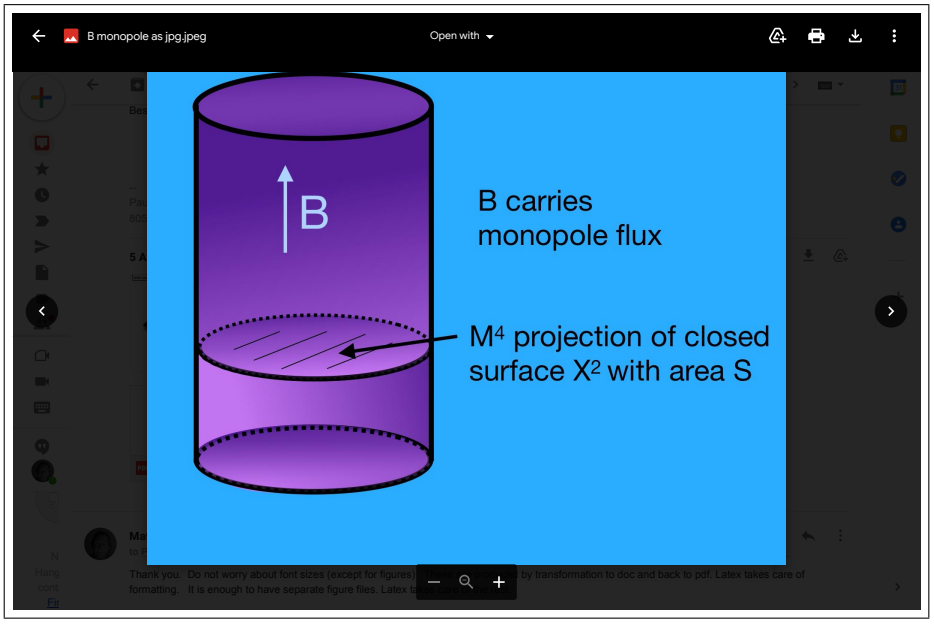

Figure 2: Monopole flux tubes

(d) Zero energy ontology and the 4-D character of the "Bohr orbits" allows us to understand memories as conscious experiences: [L27]: this is something different from memories as conditioned behaviors. Entire 4-D space-time surface would serve as a memory storage quantum entanglement between the 3-D loci of non-determinism would make possible conscious memories as an outcome of the reduction of this entanglement.

2 What principles have guided the groping in the dark?

Here are a few basic guide lines.

2.1 Start from problems

1. Get rid of logical contradictions. The basic problem of quantum measurement theory serves as an example. It is not enough to "interpret".

2. Do not resort to illusionism. Consciousness is not an illusion and cannot be reduced to a property of matter. The experience of free will is not an illusion. If existing physics cannot explain it, new physics is needed.

3. Challenge the old dogmas. These include materialism, length scale reductionism, Einstein's view about the geometrization of physics, the existing view of quantum theory. Principles first: then equations.

4. Challenge the existing thinking habits.

   (a) Is our view of space-time correct. Is it correct to speak of space-time as something unique and fixed? Should one speak of space-times rather than space-time? Is the Einstein's view of geometrization of space-time correct?

   (b) Do we really understand what classical fields are? Is QFT assuming point-like particles and plagued by divergences a correct description.

(c) Can we really identify the geometric time of physicist and subjective time. They are known to be different!

(d) Is our past fixed or can it change?

(e) Do we really understand what information is?

(f) Is life only biological. Could it be universal and appear in all scales?

5. Do we really understand quantum mechanics?

   (a) Does the Universe become classical in long scales or do the quantum measurements make to look effectively classical? Minev's findings suggest that quantum jumps correspond to continuous time evolution between the initial and final state [L7].

   (b) Is classical physics mere approximation or an exact part of quantum theory? Could it be that Bohr orbits were much more than an approximation. Can one talk about space-times as analogs of Bohr orbits as holography = holomorphy principle of TGD strongly suggests. Can one have wave functions in the space of Bohr orbits.

   (c) What happens in state function reduction (SFR)? Are the interpretations only an attempt to put a logical paradox under a rug? What about Zeno effect.

   (d) Could the value of Planck constant have a spectrum, which would make possible quantum coherence in arbitrarily long scales? Could the strange effects of ELF em fields on the vertebrate brain observed by Blackman [J2] and others be seen as a support for this?

   (e) How to define the notion of a quantum coherence region? In algebraic QFTs it is entire Minkowski space and this leads to weird looking conclusions. Is the idea about space-time extending to infinity too strong an idealization.

6. Try to get rid of the anomalies. Anomalies can be found on all scales. Biological evolution is one of the most important anomalies. It is just the opposite of heat death.

2.2 Mathematical guidelines

1. One must get rid of the infinities. The path integral formalism of QFTs is based on the concept of a point-like particle. The replacement of point with string did not work. What about 3-surfaces?

2. Take seriously the problems of the existing view: Einstein's geometrization leads to the energy problem meaning the loss of classical space-time symmetries. It must be modified to solve this problem. Could one regard space-times as surfaces in $H = M^4 \times S$?

3. The Universe must be unique from its mathematical existence. Also a harmony with the known physics is required. Infinite-D geometries require maximal symmeries to exist. Could this fix the "world of classical worlds" (WCW) as the space of "Bohr orbits" and in this way make classical theory an exact part of quantum theory? What about number theory: classical number fields are highly unique. Could number theory as a part of physics help to fix physics? Could generalization of Langlands correspondence stating that geometry and number theory are in some dual to each other.

4. Is there any need to assume any physical universe behind its mathematical representation. If the conscious experience is in the quantum jumps, this is not necessary. Ontology would simplify dramatically.

3 What exists?

There are two basic forms of existence. Subjective existence and physical = mathematical existence. They correlate but do not reduce to each other.

Could subjective existence be between two quantum jumps?Conscious experience would be associated with the replacement of a quantum state with a new one: a re-creation of the quantum sub-Universe.

3.1 Physical existence as mathematical existence

Universe as Quantum-Platonia? What is mathematically internally consistent, exists.

3.1.1 Geometric vision

1. Spacetimes as 4-surfaces: $X^4 \subset H = M^4 \times CP_2$ and orbits of particles as 3-surfaces replacing point-like particles of quantum field theories.

   (a) Holography= holomorphy principle.

   General coordinate invariance → zero energy ontology (ZEO). One must get rid of path integral leading to unavoidable diverges. Holography makes this possible. Space-time surfaces are analogous to Bohr orbits for particles as 3-surfaces. Holography = holomorphy principle reduces Riemannian geometry to algebraic geometry and solves the theory exactly.

   4-D Bohr orbits are minimal surfaces and not quite deterministic: this happens already for 2-D minimal surfaces. 4-D Bohr orbit would be the basic object, "quantum of space-time". Quantum TGD could be seen as an analogy of wave mechanics. This leads to zero energy ontology (ZEO), which solves the basic problem of quantum measurement theory without interpreting.

   (b) The "world of classical worlds" (WCW) would be identifiable as the space of 4-D Bohr orbits. Spacetime would not be given and fixed. Infinite-dimensional geometric existence is highly unique: maximal symmetries are required already in the case of loop spaces [A1]. Similar uniqueness applies in number theory.

   Quantum states are identifiable as wave functions in WCW or more precisely: spinor fields in WCW defining Quantum Platonia. Quantum jumps would occur between these and make Quantum Platonia conscious.

   (c) Conscious entities have perceptive fields possibly identifiable as causal diamonds $CD = cd \times CP_2$ [L19] already described (see this).

2. Fermions are needed as a part of dynamics.

   (a) Fermions as correlates of Boolean cognition. Spinor structure can be seen as a square root of geometry: gamma matrices defining it anticommute to metric. Fock states of fermions give rise to representations of Boolean algebra so that fermions could be seen as a correlate of Boolean logic as an aspect of cognition.

(b) Fermions are free. They satisfy the free Dirac equation in 8-D space $H = M^4 \times CP_2$. Induced spinor fields $X^4 \subset H$ are free too. If fermions have self-interactions, non-renormalizable divergences are unavoidable.

(c) Critical questions: How are interactions possible at all if fermions are free? How is fermion pair creation possible?

Pair creation as a turning of a fermion backwards in time! The turning point means failure of smoothness. More generally: fermions perform 8-D Brownian motion. 4-D space-times are completely exceptional: they allow exotic smooth structures characterized by the presence of defects in the standard smooth structure. Interacting fermions are possible only in the space-time dimension $D = 4$!

3.1.2 Number-theoretic vision

Generalization of Langlands duality: number-theoretic physics is dual to geometric physics. The so-called $M^8 - H$ duality [L35, L33]. The correlates of sensory experience would be geometric and the correlates of cognition would be number-theoretic.

1. All number fields would be involved: classical and p-adic number fields; hierarchies of extensions of rational numbers; function fields associated with classical and p-adic number fields.

2. Extensions of rationals form complexity hierarchies. Effective Planck constant h_{eff} appears as a measure for algebraic complexity: h_{eff} is either the dimension of the algebraic extension of rationals or the degree of a polynomial determining the extension.

3. Galois groups appear as number theoretic symmetry groups. Galois confinement, analogous to color confinement, emerges naturally.

4. Space-time surface as a number. Space-time surfaces serve as representations of elements of function fields associate with the maps $H \to C^2$ and also for ordinary number fields. This means a generalization of the geometric Langlands duality from 2-D situation to 4-D situation. One can speak of Quantum Platonia!

5. The embedding space H has a generalized complex structure involving hypercomplex structure in M^4 as part [L17]. Functions $H \to C^2$, which are analytic/holomorphic in generalized sense, define space-time surfaces X^4 as their roots [L24, L31]. Differential geometry is replaced with much more restrictive algebraic geometry. Field equations are reduced by holography = holomorphy hypothesis to algebraic equations. TGD is exactly solvable.

   (a) Soap-film analogy is essential. Space-time surfaces are minimal surfaces analogous to soap films and universal solutions for any general coordinate invariant action principle if based on the induced geometry.

   (b) The failure of the minimal surface property. Minimal surface property and holomorphy fail at 3-D surfaces analogous to the frames of soap films. For soap films, there is also a failure of classical determinism although field equations are satisfied: the non-determinism is located at the 1-D frames spanning the soap films. This generalizes to the 4-D case! 3-D loci of non-determinism correspond to interaction vertices and also to memory loci. This classical non-determinism is essential for cognition.

(c) M^8-H duality emerges as a generalization of momentum-position duality when particles are 3-surfaces or rather their Bohr orbits [L35, L33]. M^8-H duality gives a concrete picture of singularities as particle vertices at which Bohr orbits can meet. M^8-H duality corresponds to a generalization of Langlands duality from 2-D to 4-D situation.

3.2 Subjective existence

Subjective existence is in quantum jumps between two physical realities, not in the realities. Subjective existence can be seen as quantum hopping in quantum Platonia. The universe learns of itself and the additional information makes it more complex so that evolution is unavoidable. The reason is that the number of more complex space-time surfaces is infinitely larger than the number of less complex space-time surfaces.

What is the difference between cognition and sentience (sensory experience).

1. Sentience involves measurements reducing the entanglement with the external world and giving sensory information. "Big" SFRs (BSFRs) are the TGD counterparts of ordinary quantum measurements. What is new and predicted by ZEO that the continuous entity dies and reincarnates with an opposite arrow of time in BSFR (see the illustration).

2. Cognition involves cognitive measurements ("small" SFRs (SSFRs)) related to the non-deterministic discrete degrees of freedom assignable to cognition. In SSFRs the arrow of time remains the same. Self as a conscious entity is identified as sequence of SSFRs. Number-theoretic physics provides correlates of cognition. Classical number fields: reals, complex numbers, quaternions, octonions, extensions of rationals, p-adic number fields and function fields.

4 What can be known?

What do we mean with information?

1. Genuine information is basically conscious information: always about something unlike matter, which just is. Conscious information would be in the interval of subjective time between two quantum jumps identified as "small" SFRs.

2. What is the relation between information and complexity?

   (a) Unconscious information, possibly identifiable as a complexity of a system (say the minimal length of a bit sequence defining a program) is a relative notion. This text generates different conscious information in me and my cat.

   (b) High algebraic complexity of the text and of the receive allows richer conscious information.

3. Quantum entangled pair A-B carries conscious information possessed by the system A-B about itself. This is true if A-B is not entangled with the environment. The information changes in the next SSFR. Entanglement negentropy, whatever its mathematical definition might be, measures the amount of subjective information. The ordinary entanglement entropy measures the lack of *objective* information of an outsider about A+B. The creation of objective information in quantum measurement, reducing the entanglement, reduces subjective information.

4. How to measure information content? A definition of negentropy as a measure of subjective information emerges in the number-theoretic vision. Negentropy can be identified in terms of the p-adic variants of Shannon entropy [K4, L18]. The sum of p-adic entropies over different primes defines total negentropy. Its maximum value inevitably increases with algebraic complexity. Growth implies also the growth of entropy. This conforms with the findings of biologist Jeremy England [I4] [L2]. Increase of the conscious information content seems to imply increase of the ordinary entropy.

   Is the negentropy defined in this way a measurable quantity? Cognitive entanglement is assignable to the non-deterministic internal degrees of freedom? Can it be measured at all?

5. What is knowing? Conscious knowing requires memory storage and memory recall. Memory seats as loci of classical non-determinism. This leads to the notion of four-dimensional brain. Memory can be seen as communications with the discrete cognitive degrees of freedom of the geometric past associated with the loci of non-determinism.

Cognitive entanglement negentropy as a measure of conscious information is not the negative of the ordinary entanglement entropy but sum over p-adic contributions obeying however the same kind of formula as the Shannon entropy [L36]. For a given p-adic prime p, the logarithms of probabilities P_k are replaced by the integer valued p-based logarithms of their p-adic norms $N_p(P_k)$ multiplied by a factor $log/p)/log(2)$ taking care that bit serves as the unit of information. This requires that the entanglement probabilities are rationals or belong to the extension of rationals. Suppose that they can be deduced somehow.

1. Is cognitive entanglement negentropy is useful in any way? This seems to be the case. If one takes the number theoretical physics predicted by TGD as a correlate for cognitive consciousness seriously, one can see the effects due to the reduction of negentropy at a qualitative level. In absence of metabolic energy feed needed to increase the values of h to h_{eff}, h_{eff} spontaneously decreases and the negentropic resources are reduced. The level of consciousness is reduced and the system gets tired or even loses consciousness. This can be seen as a direct qualitative support for the notion if subjective existence is accepted as something real.

2. There is however a problem [L36]. The entanglement probabilities cannot be known with an infinite precision and the approximation as a rational number can lead to very different outcomes for the negentropy defined in this way. For instance, multiplying the probabilities with a rational $r = m/n$ very near to unity such that m and n are very large integers, can change the sum of the p-based logarithms dramatically. The reason is that real and p-adic topologies are very different. The power p^n for large n approaches zero in p-adic sense but to infinity in real sense.

3. Canonical identification, crucial for the interpretation of p-adic mass calculations [L14, L32], provides an attractive way to fix the p-adic norm assigned to the real probability. Canonical identification $I : \sum x_k p^k \to \sum x_k p^{-k}$ maps p-adic numbers in a continuous way to real numbers. The inverse of I is for a finite number of the pinary digits two-valued if the number of pinary digits for the real number is finite. Otherwise the image is unique. The reason is that the p-adic numbers $-1_p = (p-1)/(1-p)$ and $1/p$ are mapped to the same real number p. The images have p-adic norms differing by a factor p and one should select either of them. If the

number of the pinary digits is finite, the p-adic image can be to have finite number of pinary digits.

This makes it possible to reliably determine the p-adic norm of the p-adic probability assigned to a real probability. It is absolutely essential that rationals (and even reals) are first mapped to p-adics. Either $r = m/n$ or the integers m and n in $r = m/n$ can be expanded in powers of p and mapped to p-adics by canonical identification. The p-adic norms of canonical images are the same.

Note that this raises the possibility that one could, at least formally, assign cognitive negentropy also with genuine real entanglement probabilities and even with ordinary probabilities.

5 About implications

5.1 What predictions can it make, and what experiments can test them?

Most predictions relate to neuroscience and quantum biology. ZEO [K6]; the number theoretic vision predicting evolution [L5] and generalizing the second law to Negentropy Maximization Principle [L18]; the notion of field/magnetic body carrying large h_{eff} phases of the ordinary matter with long range quantum coherence and implying ordinary coherence [K3]; the evolutionary survivors as systems able to communicate with each other; and universal genetic code [L15] play key roles in the model.

1. The new view of time provided by ZEO allows us to understand the strange findings of Libet [J1, J3].

2. TGD implies a new view of classical fields in which the notion of a field body, which can be gravitational, electric or magnetic, plays a key role. The field/magnetic bodies of the brain and organism play a key role. A universal communication mechanism from the cell membrane to the field body, based on frequency modulation of dark Josephson radiation, emerges. EEG would relate to the communications to the magnetic body and to control by it. This leads to detailed models for EEG and nerve pulse [K1, K5] [L22] and model for the sensory perception [L4].

   Also the surprising findings of Levin [I3] about the role of electric fields of the cell membrane can be modelled in the TGD framework [L23, L25].

3. The dark matter at field/magnetic bodies with a large value of h_{eff} has higher "IQ" and controls the ordinary biomatter and receives information from it (say by EEG). The increase of h_{eff} requires energy and the role of metabolic energy is to preserve its value distribution. Pollack effect [I2, L1, I6, I5] plays a key role in providing the energy making possible the transfer of ordinary particles to dark phases at the field bodies [L1, L3, L20, L10, L21, L16]. p-Adic length scale hypothesis [L14, L32], for which the number theoretic vision provides a justification, makes possible quantitative predictions.

4. Biology has a long list of unanswered questions. What does evolution mean at the fundamental level?; What makes possible the coherence of biosystems?; What is behind morphogenesis?; What makes biocatalysis so effective?; What is the precise role of metabolism?; What is the essence of homeostasis?; What does ageing mean?; How to solve various hen-and egg problems of biology.

Second list of questions relates to the molecular level. How were the key biomolecules chosen?; What happens in DNA replication, transcription and translation; What is the origin of the genetic code?

The TGD view of consciousness and quantum theory allows a possible answer to these questions. [L6].

5. TGD predicts a universal genetic code realized in terms of a completely unique tessellation of hyperbolic 3-space [L12, L15], which is in a central role in TGD. Genetic code should have realizations in all scales and also very many different realizations. One example, in terms of dark photons.

6. Also new lifeforms are predicted. In particular, plasmoids [L16] are such a lifeform and NASA has reported evidence for this kind of lifeforms in the ionosphere. TGD also allows us to consider the possibility of conscious computers as hybrids of ordinary and quantum computers using topological qubits realized in the TGD framework [L28, L34].

5.2 How the model expands human knowledge and supports a postmaterialist paradigm?

One must be cautious with what one means with the notion of "post materialistic paradigm". TGD does not propose that this paradigm should be based on idealism. The ontology behind TGD differs from both the materialistic ontology denying subjective existence and idealistic ontology denying the material existence. The "objective reality" is replaced with "objective realities" identified as quantum states identified as mathematical objects. Quantum Platonia having spinor fields of WCW as basic objects is a proper name for this view.

No physical reality as matter behind these mathematical entities is needed since state functions (SFRs) as quantum jumps between them explain the conscious experience. Therefore the ontology is minimal. Number theoretic vision predicts evolution as an increase of the conscious information content. ZEO provides a mechanism of conscious memory so that quantum Platonia learns of itself.

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