

# TGD inspired theory of consciousness and living systems: Part II

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## Abstract

Topological Geometro-Dynamics (TGD) proposes a unification of fundamental interactions by identifying space-times as 4-surfaces in 8-D space  $H = M^4 \times CP_2$ , whose geometry codes for standard model symmetries and geometrizes known fields. Point-like particle is replaced with 3-surface (3-space). One ends up with the notions of many-sheeted space-time and magnetic body (MB) central in TGD inspired quantum biology. p-Adic and adelic physics follows from the extension of physics to describe also the correlates of cognition and imagination. Adelic physics predicts a hierarchy of Planck constants labelling phases of ordinary matter interpreted as dark matter: the predicted quantum coherence in arbitrarily long scales is crucial for quantum biology. Quantum TGD replaces standard ontology with "zero energy ontology" (ZEO) replacing quantum state as time=constant snapshot with zero energy state (ZES) identified as a superposition of deterministic classical time evolutions - kind of quantum program. ZEO based theory of consciousness follows as a generalization of quantum measurement theory making observer part of the system, "self". State function reduction (SR) as quantum jump between ZESs solves the basic paradox of quantum measurement theory and forces to distinguish between geometric and experienced time.

In part I of the article TGD proper and the argument leading to TGD inspired quantum biology were considered. In this part the arguments leading to TGD inspired theory of consciousness are discussed.

**Keywords:** Biology, consciousness, unified theories, geometrization of physics, quantum measurement theory.

## 1 How to end up with TGD inspired theory of consciousness?

Materialism/physicalism is kind of meta problem eliminating altogether any serious consideration of the problem. Consciousness is assumed to be property of physical system

completely fixed by its physical state. Free will would be illusion. The term conscious-ness" already reflects the materialistic view. In Finnish language the word "tajunta" avoids the interpretation as a property. To proceed, one must give up physicalism. One can proceed further to TGD inspired theory of consciousness by making questions.

**Problem #1:** How free will could be consistent with the determinism of field equations? What free will could be? It seems that behaviour is built from deterministic time evolutions connecting initial and final states: functions, behaviors, computer programs. Could free be in the selection between them. This suggests a new ontology in which deterministic time evolution becomes basic entity instead of time=constant snapshot of history.

**Problem #2:** Similar problem plagues quantum measurement theory. State function reduction (SR) is non-deterministic and Schrödinger equation deterministic. This has led to myriads of "interpretations".

Problem disappears if SR selects between quantum history defined as a superposition of classical deterministic histories - preferred extremals (PEs) of classical action. Classical physics would become exact part of quantum theory rather than mere approximation. One could speak of zero energy ontology (ZEO): zero energy states (ZESs) would be superpositions of pairs of ordinary quantum states (time=constant snapshot) at different values  $t_1$  and  $t_2$  of time coordinates and only those pairs connected by deterministic time evolution would be allowed.

This would imply classical and quantum conservation laws and total quantum numbers for initial and final states would be same - for book keeping purposes one can say that total conserved quantum numbers are opposite at the two ends - this is the practice in quantum field theories. Hence the term ZES.

The classical time evolutions in the superposition defining ZES are analogous to events in classical sense. They are however not events in the sense of non-deterministic SRs and cannot involve free will.

**Problem #3:** Experienced time and geometric time of physicist are very different. Subjective time however correlates with the geometric time: contents of sensory experience correspond to moment of geometric time with accuracy of .1 second.

Are there two times and two causalities? Could subjective time correspond to a sequence of SRs occurring between ZESs. The correlation between the two times requires that in SR the temporal distance  $t_1 - t_2$  increases. Two arrows of time are possible- either  $t_1$  or  $t_2$  changes.

**Problem #4:** Observer is still an outsider in quantum theory. Observations affect the measured system but there is no attempt to understand the observer as a part of quantum system. Quantum theory of consciousness should be a generalization of quantum measurement theory. The central notion is that of self replacing that of observer.

1) Self is a system having quantum identity and thus able to remain unentangled during time evolution. Schrödinger evolution with non-trivial interactions however entangles the system immediately.

On the other hand, Zeno effect is known to occur and means that system remains un-entangled when observables are measured repeatedly. Isn't ordinary ontology enough?

In some sense conscious entity - self - should have part remaining un-entangled during subsequent measurements.

**2)** Here zero energy ontology (ZEO) comes in rescue. ZESs are superpositions of pairs of ordinary states at times  $t_1$  and  $t_2 > t_1$ . Could the state assignable to self at say  $t_1$  be un-entangled and remain unaffected during subsequent SRs affecting only the states at  $t_2$ ? Self could be identified as the development of ZES by a sequence of unitary evolutions of the active part of the state at  $t_2$  followed by SR each. Self would have passive part  $P$  corresponding to  $t_1$  - the unchanging part of self and the active part  $A$  assignable to  $t_2$  corresponding to sensory input and everything related to it.

Self would be a generalized Zeno effect.  $t_2$  would increase - at least in statistical sense in each unitary evolution between two SRs. The increase of  $t_2$  would correspond to the increase of clock time. There would be the desired correspondence between experienced time as a sequence of these SRs and geometric/clock time as  $t = t_2 - t_1$ . The sensory input and all induced by it would come from these SRs and allow to assign clock time to experienced time flow.

The SR in question cannot correspond to ordinary SR since in standard quantum theory nothing would happen in it (Zeno effect). This "small" SR (SSR) is however analogous to so called weak SR (see <http://tinyurl.com/zt36hpb>) which is much like classical measurement.

**3)** What about standard SR - the "big" SR (BSR)? Above it was assumed that  $t_1$  corresponds to  $P$ . Why also why  $t_2 > t_1$  could not correspond to  $P$ ? The arrow of time a property of ZES would be reversed. Could BSRs correspond to SRs changing the roles of  $A$  and  $P$ . The identification would be as "death" of self and reincarnation as self with opposite arrow of time. These reduction would take place routinely in elementary particle scales, where the lifetimes of selves would be shorter. In the next BSR self would reincarnate in the original arrow of time.

**Problem #5:** Are we the only conscious systems or is pan-psychism realized in some sense? For physicist it is very difficult to imagine anything but pan-panpsychism. There would be self hierarchy corresponding to length scale hierarchy. Self would have sub-selves, which it experiences as mental images. Sub-sub-selves would be experienced as kind of averages. Self in turn defines mental image of self above it. These 3 preferred levels in hierarchy for given self would correspond to super-ego-ego-Id triplet of Freud.

The sequence of reincarnations can be experienced by self in the phenomenon of after images in which visual (say) mental image re-appears repeatedly. The time reversal of the mental images would not be experienced by self.

**Problem #6:** How to realize ZEO physically? Standard quantum theory does not allow the realization of ZEO. TGD framework led to ZEO and to a realization for the notion of self.

**1)** Zero energy ontology (ZEO) involves the hierarchy of causal diamonds (CDs) as correlates for perceptive fields of selves. The idea about ZES as pair of states at time  $t_1$  and  $t_2$  is not natural in TGD framework and is replaced with a notion consistent with the infinite-dimensional symmetries of TGD assignable to the light-cone boundary and to light-like 3-surfaces which play key role in TGD.

2) Causal diamond ( $cd$ ) formed as an intersection of future and past directed light-cones of  $M^4$  is the basic notion.  $cd$  is formed as spherical light front expands for time  $T/2$  and contracts for time  $T/2$  after that. The temporal distance between the tips of  $cd$  is  $T$ . The boundary of  $cd$  has two pieces opposite to each other. They are parts of light-cone boundary meeting at the sphere  $r = T/2$ . At the level of  $H$   $cd$  is replaced with  $CD = cd \times CP_2 \subset M^4 \times CP_2$ .

CD is identified as a imbedding space correlate for self determining the perceptive field of self. One has actually entire hierarchy of CDs within CDs with varying quantized size assignable to self hierarchy.

3) ZESs are superpositions of deterministic classical time evolutions connecting passive "lower" boundary  $P$  and active "upper" boundary  $A$  of CD. The classical deterministic time evolution corresponds to a space-time surface - preferred extremal (PE) - connecting the 3-surfaces at  $P$  and  $A$ . There are also spinor fields obeying deterministic dynamics dictated by super-conformal symmetry.

4) The active boundary  $A$  of CD moves farther away from the passive boundary  $P$  by unitary time evolutions inducing de-localization of  $A$ . SSR induces localization of  $A$  and after it ZES corresponds to single CD. The temporal distance between the tips of CD increases in statistical sense.

In BSR the roles of  $A$  and  $P$  change and the former  $P$  begins to shift to opposite direction of geometric time. CD however increases in statistical sense all the subjective time. This increase would correspond to cosmic expansion. Could selves evolve gradually eolve to entire cosmologie? Their energy content would increase. tYhis is not prevented by ZEO: classical conservation laws hold true for all PEs but due to the localizations of CDs energy conservation in quantal sense can be broken slightly.

**Problem #7:** What about the physical and possible space-time correlates for cognition and imagination?

1) p-Adic number fields,  $p = 1, 2, 3, 5, 7, \dots$  [Freund and Brekke, 1993] obtained as completions of rationals emerged to TGD via p-adic mass calculations relying p-adic length scale hypothesis (see <http://tinyurl.com/y3auow4a>) are for several reasons natural candidates for the correlates of cognition. p-Adic topology defined by ultrametric was proposed already by Parisi [Parisi, 1992] to be natural for description of cognition. Non-determinism of p-adic differential equations due to the p-adic pseudo-constants having vanishing derivative but depending on finite number of pinary digits serves as a natural space-time correlate for imagination. Only the regions in which pseudo-constant are genuine constants have real counterparts and are realizable imaginations.

2) p-Adic physics would be a natural correlate for cognition. Correlates of imagination would be space-time sheets obeying the same field equations as real ones. Cognitive representation are discrete and finite and would consist of a discrete sets of point of space-time surface for which imbedding space coordinates belong to an extension of rationals so that they are shared by real and various p-adic space-time sheets.

**Problem #8:** How to understand intelligence and evolution of intelligence?

1) p-Adic number fields allow an infinite number of extensions induced by finite-dimensional extensions of rationals: besides algebraic extensions one can have extensions defined by roots of  $e$ . These define a hierarchy in which algebraic complexity increases.

2) The natural interpretation for the increase of the dimension of algebraic extension of rationals is as increase of the complexity of cognition and evolution can be assigned to the increase of extension of rationals. The value of effective Planck constant  $h_{eff}/h_0 = n$  introduced by observations about effects of ELF em fields on brain and proposed to label a hierarchy of dark matters as phases of ordinary matter could correspond to the dimension of extension. The larger the value of  $n$ , the large the scale of quantum coherence, and the more complex the living systems in question.

**Remark:** Shannon formula with the logarithm of probability replaced with the logarithm of the p-adic norm of probability allows negative values of Shannon entropy having interpretation as information associated with the entanglement [Pitkänen, 2017b] (see <http://tinyurl.com/ycxm2tpd>). Ordinary entanglement entropy measures the ignorance about the state of either entangled system.

3) All p-adic numbers fields are needed and this leads to a fusion of reals and the extensions of p-adic number fields induced by given extension of rationals to form an adèle [Pitkänen, 2017a] (see <http://tinyurl.com/ycbhse5c>). The hierarchy of adèles defines an evolutionary hierarchy. The dimension  $n = h_{eff}/h_0$  of extension serves as a universal "IQ". Evolution is unavoidable since  $n$  must grow in statistical sense since the number of extensions larger (smaller) than given extension is infinite (finite).

4) A physical correlate for ethics is suggestive. Good deeds increase conscious information of the Universe. Bad deeds reduce the conscious information. Bad deeds indeed force secrecy and reduction of conscious information: evil doer does not usually boast with his deeds and unethical acts lead to secrecy.

These question represent only a small fraction of what must be understood. What are the correlates for directed attention, intentionality, emotions, memory, anticipation, qualia, etc..

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