

TGD inspired theory of consciousness and living systems

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Abstract

If the recent experimental findings by Minev et al are replicable, one is forced to challenge the basic assumption of the standard quantum measurement theory stating that state function reductions occur completely randomly and instantaneously. Rather, state function reduction (SR) looks like a continuous, deterministic process. The findings even suggest that SR gives a detectable warning signal and can be prevented: this would be like Zeno effect.

Zero energy ontology (ZEO) based view about quantum measurement and the relationship between geometric subjective time could explain why state function reduction looks like a deterministic process and one can apparently anticipate it in TGD framework: this is however an illusion.

The fact that the absence of the signal inducing quantum jump does not affect the occurrence of quantum jump suggests that the "flight" period indeed represents the classical evolution *after* the quantum jump in the reversed direction of time so that the absence of the external signal would not anymore affect the situation.

The most plausible interpretation for the control signal apparently stopping the reduction process is that it induces the reversal of the quantum jump already occurred. A careful analysis to distinguish between subjective and geometric time and arrows of time for the observer and atom would be needed. Interestingly, the Libet's findings that conscious decision is preceded by neural activity could be interpreted in the same manner.

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1 Introduction

I encountered a very interesting ScienceDaily article "*Physicists can predict the jumps of Schrödinger's cat (and finally save it)*" (see <http://tinyurl.com/y51pe2eo>). The experimental findings described in the article are extremely interesting from the point of view provide by TGD inspired quantum measurement theory relying on Zero Energy Ontology (ZEO) and provides a test for it.

In standard quantum measurement theory (Copenhagen interpretation) of Bohr quantum jump is random in the sense that it occurs with predictable probabilities to an eigenstate of the measured observables. Quantum jumps are also instantaneous and their occurrence cannot be predicted and even less prevented - except by monitoring - Zeno effect.

The findings of Minev et al are described in the article "*To catch and reverse a quantum jump mid-flight*" [B1] (see <https://arxiv.org/abs/1803.00545>). The outcome of quantum jump is

indeed unpredictable but the time of occurrence is to high degree predictable: there is a detectable warning signal, period of “flight” from the initial to the final state!

A curious feature is that the external signal responsible for the quantum jump can be stopped during the “flight” from the initial to final state. As if the quantum jump is analogous to a domino effect. It is also claimed that the jump can be reversed during flight period by a control signal: if jump has already occurred then one might argue that the control signal induces quantum jump in opposite direction when applied at time which is roughly the mid-time of “flight”.

If the findings by Mineev et al are replicable, one is forced to give up the basic assumption of the standard quantum measurement theory stating that state function reductions occur completely randomly and instantaneously. State function reduction (SR) looks like a continuous, deterministic process. Bohr’s theory would be dead also officially and one must finally go back to the blackboard and start serious thinking about fundamentals. It took 92 years - almost a century! State function reduction (SR) is definitely more complex phenomenon than predicted by Bohr.

What is most intriguing that SR looks smooth, deterministic classical time evolution although the outcome is not predictable. People loving hidden variables might be happy but better to think about this more precisely before jumping to any conclusions. Authors apply so called quantum trajectory theory to describe the findings [B2] and report that the model is able to predict the parameters of the parameterization with one per cent accuracy.

Zero energy ontology (ZEO) based view about quantum measurement and the relationship between geometric and subjective time explains why state function reduction looks like a deterministic process. Unfortunately, what ZEO is, is not completely clear [L3]. This allows to consider two options.

1. Both options imply that one can apparently anticipate quantum jump. This could be however an illusion: the observed classical time evolution could occur *after* the quantum jump in opposite direction of time. The fact that the absence of the signal inducing quantum jump does not affect the occurrence of quantum jump suggests that the “flight” period indeed represents the classical evolution after the quantum jump in the reversed direction of time so that the absence of the external signal would not anymore affect the situation.

The most plausible interpretation for the control signal apparently stopping the reduction process is that it induces the reversal of the quantum jump already occurred. A careful analysis to distinguish between subjective and geometric time and arrows of time for the observer and atom would be needed. Interestingly, the Libet’s findings that conscious decision is preceded by neural activity could be interpreted in the same manner.

2. The more conventional option nearer to the interpretation of experimenters is that the observed time evolution occurs *before* the quantum jump in standard direction. The period before quantum jump consists of a sequence of “small” state function reductions - “weak” measurements. $M^8 - H$ duality suggests a concrete assignment of the moments of time to them [?] and there would be also the last moment of this kind. After these things proceed to “big” state function reduction in analogy with domino effect. It is not however obvious why the classical time evolution should appear to converge to the final outcome deterministically so that this option does not look plausible.

2 First ZEO based based view about the findings

What about TGD and zero energy ontology (ZEO) based quantum measurement theory [K1]? Could it explain the revolutionary findings?

1. The new element is that quantum states are not time= constant snapshots for time evolution but superpositions of entire deterministic time evolutions at the level of space-time surfaces and at the level of induced spinor fields. SR replaces super position of classical time evolutions with a new one. This like selecting and starting new deterministic computer program. Non-determinism is in these choices [L2].
2. The notion of causal diamond (CD) identified as an intersection of future and past directed light-cones of M^4 with points replaced with CP_2 is crucial. The notion of CD is strongly

suggested by the gigantic symmetries of CD essential for the construction of quantum TGD. CD could be seen as imbedding space correlate for the perceptive field of a conscious entity - self. The upper boundary of CD - to be called active boundary A represents the boundary for space-time region from which self can receive classical signals and is therefore natural. The lower boundary, to be called passive boundary B, brings in mind cosmic expansion and follows as a prediction from $M^8 - H$ duality.

3. There are two kinds of state function reductions in ZEO.

(a) In “small” SRs (SSRs) the states change at active boundary of causal diamond (CD) (call it A) but remain unchanged at passive boundary (call it P): generalized Zeno effect occurs at the passive boundary and “weak measurements” (see <http://tinyurl.com/zt36hpb>) at A. The observables measured commute with those determining the states at P as their eigenstates. In particular, the location of A is measured localizing it and corresponds to the measurement of time as distance between the tips of CD.

“Big” SRs (BSRs) reverse the arrow of time of zero energy states and the roles of A and P. BSR is preceded by a sequence of SSRs - “weak” or almost classical measurements. In TGD inspired theory of consciousness [L2, L3] [K2] this sequence defines the life cycle of a conscious entity - self.

What is of crucial importance that BSR creates the illusion that it is an outcome of a continuous process: this realizes quantum classical correspondence (QCC). Standard observer assumes standard arrow of time and the space-time surfaces in the final time reversed state seem to lead to the the 3-surface serving as a correlate for the final state! As if BSR would be outcome of a smooth deterministic process, which it is not! There is actually a superposition of these 3-surfaces at A after BSR but in the resolution used this is not detected. Putting it more precisely:

1. The time reversal of time evolution is in good approximation obtained by time reflection symmetry T but not quite since T is slightly broken. This is extremely small effect.
2. Before BSR one has a distribution of 3-surfaces X^3 defining the ends of space-time surfaces X^4 at A: 3-surfaces X^3 corresponds to different outcomes of BSR and can differ dramatically. Observer is not conscious of this. This is like a situation of Schrödinger cat before measurement: it is impossible to be conscious about the superposition of dead and alive cat. After BSR one has quantum superposition of space-time surfaces directed to geometric past. Near the end of space-time at A they look like leading to a unique classical counterpart of final state of state function reduction. As if the state function reduction were a smooth, continuous, deterministic process. BSR guarantees this but BSR is not a smooth evolution.

The experimental findings could be understood by applying this general picture.

1. One can assign to the evolution from initial state G of atom at P to final state E at A a sequence of small reductions, weak measurements and also superposition of classical time evolutions approximated by single evolution in given measurement resolution. The state E is superposition of various measurement outcomes and each of them corresponds to a superposition of space-time surfaces identical in the measurement resolution used.
2. Then occurs the BSR: atom jumps from state E to state D. This selects from the superposition of space-time surfaces/time only the evolutions apparently leading to D. Or more precisely: the superposition of reversed time evolutions starting from D at A and very similar near A but deviating farther from it. The illusion about continuous, smooth, deterministic time evolution from G to D is created!
3. Also the possibility to anticipate the reduction would be an illusion due to the different arrows of time for observer and the observed system after BSR. The time reversed time evolution actually starts from the final state. The warning signal (absence of photon emission would be natural consequence of the reduction but in reversed arrow of time. The illusion would be due to the identification of arrows of time of observer and the atom that made state function reduction. This conforms with the observation that one can drop away the periodic signal

inducing the quantum jumps during the “flight” period identified as the deterministic process representing the quantum jump.

The lesson would be that one must always check whether the arrow of time for the target of attention is same as my own. Not a good idea to be on the wrong lane (means death also in ZEO based consciousness theory).

It is also claimed that one can prevent the quantum jump using a signal during the “flight” period. Generalized Zeno effect is basic element of TGD but the signal forcing the state to remain in P would be present before the quantum jump. This would suggest that the control signal induced quantum jump in opposite direction. To really understand the situation a careful analysis of the relationships between subjective and geometric times of observer and between geometric time of observer and atomic system after and before the quantum jump would be needed.

Also Libet’s findings about active aspects of consciousness [J1] can be interpreted in ZEO along the same lines. The observation that the neural activity begins before conscious decision can be understood by saying that the act of free will as a big state function reduction changed the arrow of time for an appropriate subsystem of the system studied. The time reversed classical evolutions from the outcome of the volitional action were interpreted erratically as a time evolution leading to the conscious decision. A less precise manner to say this is that conscious decision (big state function reduction) sent a classical signal to geometric past with opposite arrow of time initiating neural activity. Libet’s finding led physicalistic neuroscientists to conclude that free will is an illusion. The actual illusions were physicalism and the belief that arrow of time is always the same.

To sum up, ZEO is fantastic magician. Maybe this magic is necessary for the mental health of observer: a world without this illusion would be like nightmare where one cannot trust anything.

3 Second ZEO based based view about the findings inspired by $M^8 - H$ duality

I have learned to take experimental findings very seriously and I am ready to ask whether the above described option the only possibility allowed by ZEO or can one think other alternatives? It would be nice to answer “No” but one can consider variants of ZEO [L3] inspired by so called $M^8 - H$ duality [L1, L4].

The sequence of “small” state function reductions (SSRs) should have the last one. Is the “big” state function reduction (BSR) forced by some condition? One idea is that the life cycle of self corresponds to a measurement of all observables assignable to the active boundary A of CD and commuting with those defining the unaffected states at passive boundary P are measured (time as a location of A belongs to these observables measured in each SSR).

I have discussed in [L3] possible modifications of ZEO inspired by so called $M^8 - H$ duality [L1, L4]. One motivation is that time flow as shifting M^4 time $t = constant$ hyper-plane can be argued to be more natural than that for light-cone boundary. Light-cone boundaries are however favored by its huge symmetries essential for the definition of the geometry of “world of classical worlds” (WCW). $M^8 - H$ duality forces passive light-cone boundary P and the identification of A as boundary of region where sensory signals can arrive to self is natural.

$M^8 - H$ duality allows to consider variants the original ZEO.

3.1 $M^8 - H$ duality

Let us first briefly summarize what $M^8 - H$ duality [L1] is.

1. $M^8 - H$ duality is one of the key ideas of TGD, and states that one can regard space-times as surfaces in either complexified octonionic M^8 or in $M^4 \times CP_2$. The dynamics M^8 is purely algebraic and requires that either tangent or normal space of space-time surface is associative (quaternionic).
2. The algebraic equations for space-time surfaces in M^8 state the vanishing of either the real or imaginary part (defined in quaternionic sense) for octonion valued polynomial $P(o)$ with

real coefficients. Besides 4-D roots one obtains as universal exceptional roots 6-spheres at boundary of the light-cone of M^8 with radii given by the roots r_n of the polynomial in question. They correspond to the balls $t = r_n$ (t is octonionic real coordinate) inside Minkowski light-cone with each point have as fiber a 3-sphere S^3 with radius contracting to zero at the boundary of the light-cone of M^4 . These 6-spheres are clearly analogous to branes connected by 4-D space-time surfaces.

3. The intersections of space-time surfaces with 6-spheres would be 2-D and I have interpreted them as partonic 2-surfaces identifiable as topological particle reaction vertices - partonic 2-surfaces - at which incoming and outgoing light-like 3-surfaces meet along their ends. These light-like 3-surfaces - partonic orbits - would represent the boundaries between space-time regions with Euclidian and Minkowskian signatures of the induced metric. Partonic 2-surfaces would be analogs of the vertices of Feynman diagrams. The boundaries of string world sheets predicted as singularities of minimal surfaces defining space-time surfaces would be along the partonic orbits and give rise to QFT type description using cognitive representations and analogs of twistor diagrams consisting of lines.

3.2 $M^8 - H$ duality and consciousness

One can ask whether $M^8 - H$ duality and this braney picture has implications for ZEO based theory of consciousness. Certain aspects of $M^8 - H$ duality indeed challenge the recent view about consciousness based on ZEO (zero energy ontology) and ZEO itself.

1. The moments $t = r_n$ defining the 6-branes correspond classically to special moments for which phase transition like phenomena occur. Could $t = r_n$ have a special role in consciousness theory?
 - (a) For some SSRs the increase of the size of CD reveals new $t = r_n$ plane inside CD. One can argue that these SSRS define very special events in the life of self. This would not modify the original ZEO considerably but could give a classical signature for how many ver special moments of consciousness have occurred: the number of the roots of P would be a measure for the lifetime of self and there would be the largest root after which BSR would occur.
 - (b) Second possibility is more radical. One could one think of replacing CD with single truncated future- or past-directed light-cone containing the 6-D universal roots of P up to some r_n defining the upper boundary of the truncated cone? Could $t = r_n$ define a sequence of moments of consciousness? To me it looks more natural to assume that they are associated with very special moments of consciousness.
2. For both options SSRs increase the number of roots r_n inside CD/truncated light-one gradually and thus its size? When all roots of $P(o)$ would have been measured - meaning that the largest value r_{max} of r_n is reached -, BSR would be unavoidable.

BSR could replace $P(o)$ with $P_1(r_1 - o)$: r_1 must be real and one should have $r_1 > r_{max}$. The new CD/truncated light-cone would be in opposite direction and time evolution would be reversed. Note that the new CD could have much smaller size size if it contains only the smallest root r_0 . One important modification of ZEO becomes indeed possible. The size of CD after BSR could be much smaller than before it. This would mean that the re-incarnated self would have "childhood" rather than beginning its life at the age of previous self - kind of fresh start wiping the slate clean.

One can consider also a less radical BSR preserving the arrow of time and replacing the polynomial with a new one, say a polynomial having higher degree (certainly in statistical sense so that algebraic complexity would increase).

3.3 Is a more conservative view possible?

Could this picture allow to build a more conservative picture more akin to that proposed by experimenters?

1. The interpretation of the detected time evolution as that *before* the quantum jump would conform with the interpretation of experimentalists that a kind of domino effect is involved and also with the observation that stopping the signal causing the quantum jumps does not anymore affect the situation.
2. It is however unclear how to understand why the evolution looks like leading to the outcome unless the sequence of r_n 's defines a sequence of steps gradually taking the system near the final state.
3. What about preventing the BSR by external signal and even reversing the quantum jump? This would require an external perturbation of the octonionic polynomial increasing the value of the largest root r_{max} or even the degree of the polynomial and bringing in additional significant moments of life. Is it possible to speak about external perturbations of the coefficients of polynomials assumed to be rational numbers? The perturbations would come from a higher level in the hierarchy of selves (experimentalist), and one can imagine them in the framework of many-sheeted space-time.

To sum up, to my opinion (which could change) the first option looks more plausible. The introduction of moments $t = r_n$ as special moments in the life of self looks highly attractive and also the possibility of wiping the slate clear.

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