

Challenging the interpretation of Zero Energy Ontology

July 20, 2026

Matti Pitkänen

orcid:0000-0002-8051-4364.

email: matpitka6@gmail.com,

url: http://tgdtheory.com/public_html/,

address: Valtatie 8, as. 2, 03600, Karkkila, Finland.

Abstract

In holography = holomorphy (H-H) principle the basic objects are not 3-D surfaces but their slightly non-deterministic Bohr orbits. This forces zero energy ontology (ZEO), which solves the basic problem of quantum measurement theory. Classical non-determinism is associated with the edges of the space-time surface and plays a fundamental role in both the TGD inspired theory of conscious experience and basic quantum TGD. It is assumed that edges correspond to "small" state function reductions (SSFRs) in which quantum decoherence is assumed to occur. This also occurs in "big" SFRs (BSFRs) as the TGD counterparts of ordinary state function reductions in which also the arrow of geometric time changes. There are, however several open questions related to ZEO.

1. Are SSFRs really SFRs associated with the edges of the space-time surface or does their sequence define a TGD finite counterpart of Feynman path integral so that no decoherence would occur?
2. There are also questions related to the details of the periods consisting of SSFRs. The increase of the size of causal diamond (CD) by scalings occurring in SSFRs would allow us to understand how subjective a sequence of SSFRs corresponds to geometric time as distance between the tips of CD.

The alternative proposal is that CD shifts gradually to the direction of the active boundary of CD at which the states do not remain fixed in SSFRs. Which option is correct? Does the size of the CD increase indefinitely or does it reduce in BSFRs so that conscious entities would experience childhood after every BSFR? Is the breaking of T symmetry (and also CP symmetry) necessary for the gradual shift of CD to a fixed time direction?

3. The feed of metabolic energy is necessary for consciousness. Sleep and wakeup can be identified as conscious states with opposite arrows of geometric time. Does the periodically varying feed of the metabolic energy from the Sun as light, making also possible direct visual perceptions, give rise to a stochastic resonance in which the state of consciousness corresponds to flips between the potential wells of a bistable system.

Contents

1	Introduction	2
1.1	The notion of causal diamond	2
1.2	"Big" state function reductions	2
1.3	"Small" state function reductions	2

2	Problems related to ZEO	3
2.1	Are SSFRs really SFRs?	3
2.2	How could the arrow of geometric time emerge?	3
2.3	Sleep-wake cycle and metabolism	4

1 Introduction

In Zero Energy Ontology (ZEO), the superpositions of space-time surfaces inside causal diamond (CD) having their ends at the opposite light-like boundaries of CD, define quantum states. CDs form a scale hierarchy (see the this) and this).

1.1 The notion of causal diamond

The notion of causal diamond (CD), identified as the intersection of future and past directed lightcones, is the cornerstone of zero energy ontology (ZEO). The notion of CD is discussed in [L2]. In ZEO, forced by holography = holomorphy principle [L4, L5], the basic physical entities of TGD are not 3-surfaces but their 4-D slightly non-deterministic Bohr orbits inside CD.

CDs form a scale hierarchy and one could see CD as a geometric correlate of physical system at the level of H . The moduli space of CDs Poincare transformations and Lorentz boosts leaving the tip of invariant.

1.2 "Big" state function reductions

Quantum jumps occur between superpositions of 4-D time evolutions and the basic problem of the standard quantum measurement theory disappears. Ordinary state function reductions (SFRs) correspond to "big" SFRs (BSFRs) in which the arrow of time changes (see the illustration). This has profound thermodynamic implications and the question about the scale in which the transition from classical to quantum takes place becomes obsolete. BSFRs can occur in all scales but from the point of view of an observer with an opposite arrow of time they look like smooth time evolutions [L1].

The key question is whether there is some general criterion telling when the BSFR takes place. Could BSFR take place when the size of scaled up boundary of CD increases the size scale at which a phase transition breaking the conformal symmetry can occur. An interesting possibility is raised by the fact that conformal algebra allows an infinite fractal hierarchy of sub-algebras isomorphic to it and having conformal weights coming as multiples of the full algebra. In a transition to sub-algebra generators which acted as infinitesimal gauge transformation become generators of dynamical symmetries. Could BSFRs correspond to this kind of phase transitions at least in some cases.

1.3 "Small" state function reductions

In "small" SFRs (SSFRs) as counterparts of "weak measurements" the arrow of time does not change and the passive boundary and the states at it remain unchanged (Zeno effect). The sequence of "small" state function reductions (SSFRs) defined the TGD counterpart of the generalized Zeno effect, would correspond to an analysis having as a correlate the decay of 3-surface to smaller 3-surfaces and would also give rise to a conscious entity, self.

1. SSFRs are associated with the classical determinism at 3-D surfaces Y^3 at which generalized holomorphy and smoothness fails. The derivatives are discontinuous for H coordinates. The intersections of Y^3 with light-like partonic orbits X^3 defined partonic 2-surfaces as generalized vertices intersected by fermion lines which are light-like geodesics in H . This gives to the massivation of fermions. The classical loci of non-determinism identified as singularities of smooth structure having interpretation in terms of exotic smooth structures.
2. The discontinuities correspond to the discontinuities of reduced light velocity $c_{\#}$. It can be assigned to warped flat extremals of any action principle. The notion generalizes to general space-time surfaces if the Hamilton-Jacobi structure generalizes to a warped H-J structure.

In electrodynamics the quantity $n = c/c_{\#}$ corresponds to refractive index and dielectric constant via $n = c/c_{\#} = \sqrt{\epsilon_r}$. The time evolution of the particles as a generalized Brownian motion could be seen as a sequence of reflections and refractions at the boundaries of regions at which $c_{\#}$ changes.

This forces us to ask whether SSFR is really a SFR. Could it be that the sequence of SSFRs does not imply decoherence but is an analog of path integral. The discrete time interval ΔT approaching zero in path integral would be identified as a geometric time difference between two edges of the space-time surface and would not approach zero so that one avoids divergences of standard QFT. Or could it be that it is genuine SFR preserving the arrow of geometric time only in some special situations?

2 Problems related to ZEO

2.1 Are SSFRs really SFRs?

One can consider two alternative views of what could happen in quantum scattering event?

1. It would be nice to interpret the sequence of these edge discontinuities as an analog of a similar sequence for Feynman path integral for which the time difference ΔT between the discontinuities goes to zero. This would require giving up the idea SSFR is a genuine state function reduction giving rise to decoherence. This would mean giving up the basic idea of TGD inspired theory of consciousness.
2. On the other hand, I propose that QCD serves as a role model for the TGD view of scattering events and thus involves incoming and outgoing particles as states defined in terms of fermionic oscillator operators for the free fermion fields in H . Fermion fields in H satisfy massless Dirac equation in 8-D sense and are massive.

Quark gluon phase would be replaced with phases involving only induced fermion fields satisfying the massless Dirac equation. It seems that an excellent approximation is to consider fermions localized to fermion lines as massless light-like geodesics in H restricted to light-like geodesics in X^4 but with reduced light velocity $c_{\#}$. In M^4 the geodesics are massive and the mass corresponds to $m = \hbar_{eff}\omega$.

3. The formation of quark gluon phase would be a unitary transformation from H phase for fermions to X^4 phase and hadronization would be a unitary transformation in an opposite direction.
4. The question is whether also the SSFRs actually just unitary transformations or whether they are genuine SFRs as TGD inspired consciousness requires?

QCD is a strange looking mixture of QFT and kinetic theory. Scattering amplitudes are calculated by QFT but one has parton densities and quark-hadron fragmentation functions, which belong to kinetic theory involving quantum statistics and therefore state function reductions. If QCD view is correct, SSFRs are indeed genuine SFRs involving a loss of coherence and only the periods between two SSFRs would be unitary evolutions.

2.2 How could the arrow of geometric time emerge?

This problem is far from being finally settled. One can consider the arrow of time at the level of embedding space and space-time surface. One can imagine at several views [L2] based on the assignment of the arrow of time to the sequences of SSFRs.

1. Perhaps the simplest option is that the CD itself is shifted in the direction defined by the active boundary of CD. An argument telling how much the shift per single SSFR is would be needed. This time would correspond to the time shifted between two BSFRs. The inverse for the rate of BSFRs would give an estimate for this rate. Also the p-adic length scale assigned with the CD suggests some idea about this rate.

A simple example is provided by sleep-awake cycle. Falling a sleep and wake-up would correspond to two subsequent BSFRs and the time would be on the average roughly 12 hours, which correspond to the half of rotation period of the Earth and is also near the the oscillation period of the Earth as a gravitational harmonic oscillator [L6].

The problem is that if there is no breaking of time reflection symmetry T , the times travelled towards geometric future and past would compensate each other so that the CD would not move at all on the average. During sleep the distance travelled to future would be compensate by distance travelled to the geometric past. T and CP are broken and matter-antimatter symmetry reflects this breaking in cosmic scales. In this view the CD would be like time-snake.

2. I have also considered the possibility that the size of CD is reduced in BSFR and then grows in the sequence SSFRs. This would conform with the idea that each continous entity experiences evolution starting with a childhood. Also now T and CP breaking might be necessary to give a genuine arrow of geometric time at the level of H .
3. One possibility is that the CD suffers a scaling with respect to its center point in each SSFR. Second option is that the passive boundary remains stationary. The passive boundary of CD would be scaled and shifted but the states at it would not change by conformal invariance (scaling is a conformal transformation).

The objection is that the size of CD of any system, even elementary particle, would increase steadily and indefinitely and also the period with a given arrow of geometric time would get longer. This is not true for sleep-wake cycle. This suggests that although scalings are possible they are a rare occurrence and possibly correspond to some particylar BSFRs increasing the scale of quantum coherence and would give rise to evolution.

4. At the space-time level, the geometric time as correlate for the subjective time as sequence of SSFRs could correspond to the temporal distance between the tips of CD increasing in the sequence of SSFRs defining the self. The classical non-determinism gives rise to a sequence of singular 3-surfaces as edges of the space-time surface at which standard smoothness fails and exotic smoothness is assumed to replaced it. The increase of CD gradually would gradually reveals more edges as loci of non-determinism.

2.3 Sleep-wake cycle and metabolism

To get some more food for thought one can try to relate the sleep-wake cycle for living organisms to the metabolic energy feed from the Sun.

1. Here the notion of stochastic resonance is suggestive. It occurs for bistable systems in presence of noise and periodic force. In stochastic resonance the average time τ_K spent in a given potential well is one half of the time of the periodic perturbation T . In the recent case T would correspond to 24 hours and τ_K the average period of sleep/wake.

The states of the bistable system, describable as a potential well, would correspond to sleep and wake as states of consciousness. Under a suitable condition the rate for jumps between potential stochastic resonance occurs and the periodic signal is amplified.

2. Plants cannot store energy like animals and would be strongly dependent on the solar energy feed and sleep-wake cycle would be very regular and also explain why they cannot survive over winter time. Animals would not be so depending on solar energy feed but could not stay too long a period awake.
3. The feed of the metabolic energy is necessary during daytime. During the night-time this feed is absent. If the organisms are conscious during the period with the opposite arrow of time, they should receive metabolic energy from the Sun. This energy must be negative however! The Sun must be able to send both positive and negative energy photons. Negative energy photons do indeed exist and phase conjugate light rays are a basic example of them. The Sun has a Sunspot period of about 22 years. Could this correspond to the sleep wake cycle of the Sun at the level of its field body? Denote the half-periods of the sleep wake cycle

of the Sun by W and S and corresponding periods at the Earth by w and s . During w , the organism should receive positive energy photons from the Sun from the temporarily nearest period W . During S this would be the W preceding it. During s the organism should receive negative energy photons from the Sun from the temporarily nearest period S . During W this would be the geometrically next S .

This could have rather dramatic implications on the understanding of wake-up consciousness in long time scales. There would be a periodic dependence on the half-period of the Sunspot cycle. By the predicted universality of consciousness, these periodic dependence would not be restricted to human consciousness but appear even in microscopic scales.

4. There indeed exists evidence about the correlations with astrophysical rhythms. For instance, Shnoll [E1, E4, E5, E2, E6, E3] reported that radioactive decay rates, chemical reaction rates and biological interactions correlate with astrophysical periods. There are claims about similar correlations in the economy. I have tried to understand the findings of Shnoll in the TGD framework [L3]. These correlations are impossible in the framework of standard physics; it is not surprising that the mainstream regards these findings as an anomaly due to flawed methodology.

REFERENCES

Cosmology and Astro-Physics

- [E1] Shnoll SE et al. Realization of discrete fluctuations in macroscopic processes. *Physics-Uspekhi*, 41(10):1025–1035.
- [E2] Shnoll SE et al. Experiments with rotating collimators cutting out pencil of α -particle at radioactive decay of ^{239}Pu evidence sharp anisotropy of space. *Progr Phys*, pages 81–83, 2005. Available at: https://www.ptep-online.com/index_files/2005/PP-01-11.PDF.
- [E3] Shnoll SE et al. Fine structure of histograms of alpha-activity measurements depends on direction of alpha particles flow and the Earth rotation: experiments with collimators, 2008. Available at: <https://www.cifa-icef.org/shnoll.pdf>.
- [E4] Shnoll SE Panchelyuga VA. On the Dependence of a Local-Time Effect on Spatial Direction. *Progr Phys*, pages 51–54, 2007. Available at: https://www.ptep-online.com/index_files/2007/PP-10-11.PDF.
- [E5] Shnoll SE Panchelyuga VA. On the Dependence of a Local-Time Effect on Moving Sources of Fluctuations. *Progr Phys*, pages 55–56, 2007. Available at: https://www.ptep-online.com/index_files/2007/PP-10-12.PDF.
- [E6] Panchelyuga VA Shnoll SE. The Palindrome effect. *Progr Phys*, 2:151–153, 2008. Available at: https://www.ptep-online.com/index_files/2008/PP-13-20.PDF.

Articles about TGD

- [L1] Pitkänen M. Copenhagen interpretation dead: long live ZEO based quantum measurement theory! Available at: https://tgdtheory.fi/public_html/articles/Bohrdead.pdf, 2019.
- [L2] Pitkänen M. New result about causal diamonds from the TGD view point of view. https://tgdtheory.fi/public_html/articles/CDconformal.pdf, 2023.
- [L3] Pitkänen M. Shnoll effect decade later. https://tgdtheory.fi/public_html/articles/ShnollTGD.pdf, 2023.

-
- [L4] Pitkänen M. About Langlands correspondence in the TGD framework. https://tgdtheory.fi/public_html/articles/Frenkel.pdf, 2024.
- [L5] Pitkänen M. A more detailed view about the TGD counterpart of Langlands correspondence. https://tgdtheory.fi/public_html/articles/Langlands2025.pdf, 2025.
- [L6] Pitkänen M. Could the notions of quantum geology and quantum biology make sense? 2026. Available at: https://tgdtheory.fi/public_html/articles/qgeobio.pdf.