Does Consciousness Survive Bodily Death?

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Abstract

"*What is the best possible evidence for the survival of human consciousness after bodily death?*" is the question of this essay. It is very difficult to provide water tight evidence for life after death since near-death experiences are subjective and cannot provide an objective proof.

The situation can change if one has a testable theory of consciousness. The theory of consciousness presented here is inspired by Topological Geometrodynamics (TGD). TGD was born as a proposal for a unification of fundamental interactions, and indeed provides a general theory of consciousness as a generalization of quantum measurement theorypredicting that consciousness, life and death are universal phenomena. The theory relies on new views about space-time and classical fields, and provides a new ontology behind quantum theory that predicts that state function reduction involves time reversal.

The proposed hypothesis forces a new view about the relationship between experienced time and physicist's time, and generalizes thermodynamics so that the second law is replaced with what I call the Negentropy Maximization Principle. Also cognition is included and forces the extension of real number based physics to adelic physics. Adelic physics predicts a hierarchy of phases of ordinary matter with a non-standard value h_{eff} of the Planck constant interpreted as dark matter which for large values h_{eff} is quantum coherent in arbitrarily long scales. The theory makes testable predictions at all scales supporting the proposed view of the continuation of life after it. A model for what happens in biological death and an explanation for various aspects of near-death experiences emerges.

Keywords: Quantum consciousness; quantum biology; self-organization; self-organized criticality; dark matter;near-death experience; reincarnation; topological geometrodynamics; adelic physics; magnetic body; hierarchy of Planck constants; zero energy ontology.

Contents

1 Introduction

The questions of this essay is " *What is the best possible evidence for the survival of human consciousness after bodily death?* ". It is very difficult to provide water tight evidence for life after death since near-death experiences (NDEs) are subjective and cannot provide an objective proof.

By re-framing the question as one that addresses consciousness, the situation changes. That is, a theory of consciousness inspired by Topological Geometrodynamics (TGD), which derives from a broader proposal for the unification of fundamental interactions, provides a general theory of consciousness in which consciousness, life and death are universal phenomena. The theory makes testable predictions at all scales and supports the view that consciousness survives death albeit not in the manner one might expect.

The following represents a broad overview of the theory. A glossary of terms that may be alien to the lay reader is provided at the end of the essay.

1. The first key element of the theory is what I call the Zero Energy Ontology (ZEO) [L70]. ZEO solves the basic problem of quantum measurement theory and extends quantum measurement theory to a theory of consciousness. It does so by raising the observer from the status of outsider to that of an intrinsic part of system - the conscious entity or self. The self is born, lives and dies.

   The moments of birth and death correspond to what I describe as ("Big" State Function Reductions (BSFRs) as counterparts of ordinary state function reductions (SFRs). What is new is that in the BSFR the self re-incarnates with an opposite arrow of time. Life corresponds to a sequence of "Small" State Function Reductions (SSFRs) in which the arrow of time does not change. SSFRs are analogs of "weak" measurements.

2. The second key element is number theoretic view about cognition generalizing real number based physics to adelic physics [L23, L25]. One outcome is the identification of dark matter as phases of ordinary matter labelled by extensions EQ of rationals. The dimension n of EQ is identifiable in terms of the effective Planck constant $h_{eff} = nh_0$ ($h = 6h_0$ is suggested by findings of Mills [D3] [L27]).

   EQ induces extensions of p-adic number fields serving as correlates of cognition. [L23, L25]. "n"" measures the algebraic complexity of these extensions and therefore the level of cognition. "n" also serves as a measure for the scale of quantum coherence typically proportional to h_{eff}. For these reasons, "n" serves as a kind of universal "intelligence quotient" (IQ).

   Quantum coherence, consciousness, and life are predicted to be possible in arbitrarily long length - and time scales so that the notions of life and death are universal.

3. The third key element is a new view about space-time and about classical gauge fields and gravitational fields provided. The identification of space-time as a 4-D surface in certain 8-D space-time fixed by standard model symmetries leads to a geometrization of the classical fields and their elimination

as primary dynamical variables: once the space-time surface X^4 is known, all classical fields are also known. The many-sheeted space-time of TGD is locally extremely simple but topologically extremely complex whereas the space-time of General Relativity (GRT) is topologically extremely simple but locally complex.

The notion of a field body or *magnetic body* (MB) is central. In Maxwellian theory, the fields of different objects superpose and in this superposition information is lost. In TGD, the fields of distinct objects in general correspond to different space-time sheets and the fields do not superpose so that information is not lost. This distinction is crucial to TGD inspired quantum biology. By its higher IQ (measured by h_{eff}), MB carrying dark matter in the TGD sense acts as a master which controls the layers of MB with a smaller value of n and also the ordinary biomatter at the bottom of the hierarchy. This makes life possible at all scales.

The following describes this theory in more detail and some of the applications that suggest an affirmative answer to the question of the essay contest. In the TGD Universe, fractality replaces length scale reductionism as a foundational concept, and the notions of life and death are universal so that the question can be formulated in a much wider framework. The last section is devoted to the understanding of what happens in biological death and to the model of NDE experience.

List of abbreviations:

TGD: Topological Geometrodynamics
QFT: Quantum field theory
GCI: General Coordinate Invariance
SH: Strong form of holography
EP: Equivalence Principle
EQ: Extension of rationals
ZEO: Zero energy ontology
CD: Causal diamond
SFR: State function reduction
BSFR: "Big" (ordinary) SFR
SSFR: "Small" SSFR
NMP: Negentropy Maximization Principle
SL: Second Law of thermodynamics
NE: Negentropic entanglement
FB: Field body
MB: Magnetic body
BB: Biological body
RMS: Rotating magnetic system
NDE: Near-death experience
OBE: Out-of-body experience

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2 Brief summary of TGD

Topological Geometrodynamics is a proposal for a unification of fundamental interactions with which I have worked for the past 43 years. The books "Topological Geometrodynamics"(2006) [K12] and "Topological Geometrodynamics: Revised Edition" [K18] provide summaries of the theory of TGD. The book "Life and Consciousness: TGD based vision" (2014) [K17] describes a TGD inspired theory of consciousness. The article "Philosophy of adelic physics" (2017) [L23, L25] describes a number theory based vision about TGD and extends real number based physics to p-adic number fields to describe physical correlates of cognition. The most recent mathematical progress concerning the construction of scattering amplitudes in TGD is discussed in the articles [L57, L62, L63].

The article "Summary of Topological Geometrodynamics" (2020) [L67] provides the the most recent summary of TGD with illustrations. CV (see `http://tgdtheory.fi/curri.html`) contains list of articles and books and online books about TGD and there is list about online articles (see `http://tgdtheory.fi/tgdarticlesall.html`)

2.1 The Basic problem and idea behind TGD

TGD relies on a new view of space-time inspired by the problem of General Relativity (GRT) with classical conservation laws (i.e. the "energy problem"). Matter makes the flat Minkowski space M^4 of Special Relativity (SRT) curved so that it loses of its symmetries. Poincare invariance implies the conservation laws of energy, momentum, and angular momentum via Noether's theorem so that they are lost in GRT.

The following is a short summary of the solution of this problem provided by TGD (see **Fig. 1**.

1. If space-times are 4-surfaces in a space of form $H = M^4 \times S$, S some compact space with a very small size, space-time isometries (Poincare transformations) are lifted to those of H. If these isometries act as symmetries of a general coordinate invariant action determining the space-time surface as an orbit of a 3-surface, Poincare symmetries are not lost and Noether's theorem guarantees the existence of conserved charges and gives explicit expressions for them.

   The geometry of $S = S = CP_2$ codes for the symmetries of the standard model: color symmetries correspond to the isometry group $SU(3)$ and electroweak symmetries correspond to the holonomies of CP_2 being broken by CP_2 geometry. CP_2 does not allow spinor structure in the standard sense [L1] but - as already observed by Hawking and others [A3, A1] - it allows a modified spinor structure obtained by coupling spinors to an odd multiple of the

Kähler gauge potential: this coupling is essential to obtain correct electromagnetic charges for fermions. For quarks and leptons the couplings would correspond to $n = 1$ and $n = 3$.

However, the TGD view about color makes it possible to identify leptons as local 3-quark composites [L50, L49, L41, L61, L71] so that only quarks are needed as fundamental fermions. The mystery of matter-antimatter symmetry would be solved: leptons correspond to antimatter and baryons to matter.

2. Besides sub-manifold geometry, topology also becomes important (hence the term "**T**GD") since the many-sheeted space-time of TGD is topologically non-trivial in all scales and the physical objects that we see around us correspond directly to space-time sheets, topologically condensed at larger space-time sheet. A length scale hierarchy is formed.

2.2 Physics as geometry and physics as number theory

TGD decomposes to two basic threads: physics as geometry [L3, L2, L11, L53] and physics as number theory [L29, L30, L25] (see **Fig. 2**).

1. In the geometric approach space-time surfaces X^4 correspond to extremals for both volume action and the so called Kähler action as analog of Maxwell action. This action is predicted by the twistor lift of TGD [L18] (see **Fig. ??**).

   The essential distinction between this approach and the standard quantization is that classical physics is an exact part of quantum physics rather than its long length scale limit: quantum states are superpositions of preferred extremals of the action analogous to Bohr orbits (see **Fig. 3**) .

2. In the approach based on number theory, X^4 corresponds to an algebraic surface in a complexified 8-dimensional Minkowski space M^8 having an interpretation as complexified octonions O_c. This surface is obtained as a "root" for the complexified quaternion-valued "real" part of an octonionic polynomial obtained from a real polynomial with rational coefficients by algebraically continuing it to O_c. This is done by replacing the real argument with a complexified octonion [L62, L63] (see **Fig. 5**).

These approaches are related by the $M^8 - H$ duality [L62, L63] (see **Fig. 5**) for which weak and strong forms can be considered.

1. The identification of M^8 as an analog of momentum space meant a breakthrough [L62, L55].

2. One can realize both weak and strong forms of $M^8 - H$ duality in M^4 degrees of freedom by inversion map $p^k \in M^4 \to \hbar_{eff} p^k/p^2$ [L62]. This conforms with the Uncertainty Principle.

3. The weak form of $M^8 - H$ duality relies on the strong form of holography (SH) which allows to deduce $X^4 \subset H$ from the images of *2-D surfaces* $X^2 \subset X^4 \subset M^8$ (and possibly also of light-like 3-surfaces) under $M^8 - H$ duality [L47].

4. Recent work strongly suggests that SH may not be necessary: the strong form of $M^8 - H$ duality maps the *entirety* of space-time surfaces from M^8 to H. This means a huge simplification [L62, L63].

The identification of M^8 as an analog of momentum space meant a breakthrough but there is an objection. Periodic functions and Fourier analysis characteristic for dynamics are absent at the level of M^8. Do they emerge at the level of H? The conjecture is that the non-locality of the map of the tangent planes of $X^4 \subset M^8$ to CP_2 points brings in dynamics and implies that CP_2 points is realized as Fourier expansions of M^4 coordinates [L54, L74].

Quantum TGD leads to a generalization of the geometrization of physics program of Einstein. The entire quantum theory is geometrized in terms of the notion of a "world of classical worlds" (WCW) consisting of space-time surfaces identifiable as preferred extremals (PEs) analogous to Bohr orbits (see **Fig. 6**). General Coordinate Invariance (GCI) implies 3-D holography and probably also effectively 2-D holography (strong holography (SH)).

The mere existence of WCW Kähler geometry requires a maximal isometry group. This was shown by Freed [A2] to be the case for loop spaces. This leads to the vision that physics is unique from its existence. Indeed, the twistor lift of TGD [L51, L52] works only for $H = M^4 \times CP_2$ [A4] since only M^4, E^4, and CP_2 have twistor spaces with the Kähler structure required by the existence of the twistor lift based on 6-D Kähler action. At the number theory side, the octonionic M_c^8 is the unique choice.

The number theory based vision is a completely new element and leads to adelic physics [L23, L25] involving both real physics and various p-adic physics (where $p = 2, 3, ...$ are primes). p-Adic physics are identified as correlates of cognition and imagination predicted to be present at all scales (see **Fig. ??**).

The polynomials defining the $X^4 \subset M_c^8$ give rise to an infinite hierarchy of extensions of rationals (EQs) inducing those of p-adic number fields. One has also an infinite hierarchy of adeles. The adele for a given EQ is defined essentially as the Cartesian product of real numbers and extensions of various p-adic number fields induced by EQ.

This hierarchy is identified as an evolutionary hierarchy (see **Fig. 7**). The dimension n of EQ has an interpretation as an effective Planck constant $h_{eff} = nh_0$ ($h = 6h_0$). Quantum coherence is predicted to be possible in arbitrarily long scales and the values of "n" define a length scale hierarchy as quantum coherence scales. The phases with a non-standard value of h_{eff} behave like dark matter.

2.3 About the applications of TGD

TGD has non-trivial applications at all scales.

1. Space-time topology is non-trivial in all scales. "Einsteinian" space-time surfaces have an M^4 projection of dimension $D_P = 4$, and look like small deformations of M^4. Also 4-D space-time surfaces with $D_P < 4$ are possible and correspond to non-perturbative gravity. In particular, the so-called CP_2 type extremals with $D_P = 1$ and cosmic strings with $D_P = 2$, are possible.

These deviations from GRT are crucial for the understanding of elementary particles and galactic dark matter and energy [L48, L44].

All space-time surfaces - including "Einsteinian" ones - have a finite size. In the "Einsteinian" case, CP_2 coordinates can be many-valued functions of M^4 coordinates, and it is convenient to talk about a many-sheeted space-time.

Quantum field theory limit for the Einsteinian space-time surfaces is obtained by replacing the space-time sheets with a single, slightly metrically deformed, region of M^4. The counterparts of the standard model gauge potentials are identified as the sums of induced spinor connections of the space-time sheets. The counterpart of the GRT metric corresponds to the sum of the deviations of the induced metric from the flat M^4 metric. Einstein's equations can be regarded as a remnant of Poincare invariance. Many-sheeted space-time is topologically non-trivial in all scales and this hidden many-sheetedness leads to non-trivial predictions at all scales, in particular in biology.

2. For a given EQ fixed by a polynomial defining space-time surface $X^4 \subset M^8$ there is a unique discretization of X^4 - cognitive representation - as points, whose coordinates are common to the real and p-adic variants of X^4 and therefore in the EQ. This intersection of reality and p-adicities implies a strong correlation between cognition and reality. The p-adic length scale hypothesis that emerged from p-adic thermodynamics as a model for particle massivation [L4] and p-adic fractality are very powerful quantitative tools, which lead to highly non-trivial predictions.

For more detailed representations one can consult the books [K12, K17, K18], the article [L23] about adelic physics, and the articles [L26, L37]. The latest mathematical progress is described in the articles [L61, L62, L63, L74]. The homepage dedicated to TGD (`http://tgdtheory.fi`) contains online books and articles - also updated versions of published articles.

3 TGD inspired theory of consciousness

TGD inspired theory of consciousness can be regarded as an extension of quantum measurement theory to a theory of consciousness that relies on Zero Energy Ontology (ZEO) [L70].

3.1 Conditions satisfied by the theory of consciousness

Any quantum theory of consciousness must be consistent with the existing physics. Since the existing physics cannot explain biological phenomena and consciousness, the theory explaining them is bound to predict some new physics.

The new theory must solve the basic problems intractable to the current theoretical physics. Many of these problems are philosophical. This theory should also be applicable to quantum biology and neuroscience and answer at least the following questions.

1. In everyday life everyone, even the strict physicalist, will in their subjective experience, regard free will as real but in the role of natural scientist would deny it since it is inconsistent with the determinism of classical physics. There is nothing wrong with this logic but could the underlying view of time be wrong? Could free will be consistent with the determinism of field equations after all?

   It seems that behavior is built from deterministic time evolutions connecting initial and final states. Biological functions, behaviors, and computer programs represent good examples of this. Could free will be in the selection between deterministic time evolutions. These questions suggest a new ontology in which a deterministic classical time evolution becomes the basic entity instead of time=constant snapshot of time evolution as in the standard ontology.

2. A similar problem plagues quantum measurement theory. The state function reduction (SFR) is non-deterministic and the Schrödinger equation is deterministic. This has led to myriads of "interpretations". This problem is analogous to the conflict between free will and classical deterministic physics.

   It is easy to trace the origin of the problem. In standard quantum theory the observer can affect the measured system but still remains an outsider. There is no attempt to understand the observer as a part of the quantum system. A quantum theory of consciousness should therefore generalize quantum measurement theory. The notion of "self" should replace that of "observer".

   Quantum coherence is assumed to be possible only in very short scales. Coherence of biological systems, however, suggests that this assumption is wrong. This assumption also raises the question whether there is some scale at which the quantum behavior transforms to classical behavior. This question has not been answered. This inspires the question whether the quantum world could actually prevail in all scales and only appear as classical? Could discontinuous quantum jumps somehow look like deterministic and smooth classical time evolutions?

3. Experienced time and the geometric time of the physicist are very different. Subjective time however correlates with the geometric time: contents of sensory experience correspond to a moment of geometric time with an accuracy of .1 second: one can speak of a sensory chronon. How may one distinguish between these two times?

4. Are there physical correlates for cognition and imagination? Could they be realized at the level of space-time?

5. What do life, death, and aging mean? Could they be universal notions applicable at all scales? Is there consciousness after the cessation of bodily function in some sense? If this were the case, universality might make it possible to provide indirect and yet convincing evidence for life after death.

3.2 ZEO based quantum measurement theory extends to a theory of consciousness

ZEO based quantum measurement theory [L70] leads to a quantum theory of consciousness (see **Fig. 8**) by lifting the observer from an outsider to a part of the physical system. In particular, the theory predicts that the arrow of time changes in "Big" (ordinary) SFRs (BSFRs) (see **Fig. 10**) as opposed to "Small" SFRs (SSFRs) as the counterparts of "weak" measurements (`http://tinyurl.com/zt36hpb`).

BSFR suggests that self-organization (SO) in all scales partially reduces to dissipation with a reversed arrow of time implied by the generalization of the second law of thermo-dynamics (SL).

1. SO always involves energy feed. The energies of quantum states increase with h_{eff} and h_{eff} tends to be reduced spontaneously. Energy feed prevents this and hence the reduction of the universal "Intelligence Quotient" (IQ) as the dimension n of EQ characterizing the algebraic complexity of EQ and of space-time surface [L54, L55]. In biology this corresponds to the metabolic energy feed.

2. In ZEO the energy feed necessary for SO could be partially replaced with an extraction of energy from the environment by dissipation in a reversed direction of time. The self-organizing system could effectively send negative energy to the environment. The basic signature is a generation of gradients in conflict with SO in its standard form. This conforms with what happens in SO but does not of course prove that SO is based solely on time reversed dissipation. Both the energy feed and the extraction of energy from the environment are involved.

   For time reversed dissipation no specific mechanisms are required and only metabolic energy storages - systems able to receive the negative energy dissipated in a reversed time direction - are enough. Even thermal energy could be used and there is evidence for this [L79]. Obviously, this inspires a totally new vision, not only about living matter, but also in regards to possible energy technologies.

3. Time reversals occur in very short time scales at the elementary particle level and for ordinary matter with $h_{eff} = h$). For MBs controlling ordinary matter, time reversals would have long lasting effects on the ordinary matter as well.

   MB has an onion-like layered structure implied by p-adic length scale hypothesis and h_{eff} hierarchy. Layers have sizes even larger than Earth size. The slaving hierarchy formed by the layers of MB carrying dark matter could control the dynamics by inducing time reversals at the lower levels as BSFRs having interpretation as generalized motor actions (master and slave are standard notions in the theory of SO). A given layer of MB is characterized by its size determined by a p-adic length scale characterizing flux tube thickness and by the value of h_{eff}.

3.2.1 ZEO

The TGD based view about consciousness relies on ZEO solving the basic paradox of quantum measurement theory. First, a brief summary of ZEO [L70] is required.

1. The notion of a causal diamond (CD) (see **Fig. 9**) is a central concept. Its little cousin "cd" can be identified as a union of two half-cones of M^4 glued together along their bottoms (3-balls). The half-cones are mirror images of each other. CD=$cd \times CP_2$ is the Cartesian product of cd with CP_2 and obtained by replacing the points of cd with CP_2. The notion of CD emerges naturally in the number theoretic vision of TGD (adelic physics [L24])via the $M^8 - H$ duality [L47, L62, L63].

2. In the ZEO, quantum states are not 3-dimensional, but superpositions of 4-dimensional deterministic time evolutions connecting ordinary 3-dimensional states. By holography time evolutions are equivalent to pairs of ordinary 3-D states identified as initial and final states of time evolution.

   Quantum jumps replace this state with a new one: a superposition of deterministic time evolutions is replaced by a new superposition. The classical determinism of individual time evolution is not violated. This solves the basic paradox of quantum measurement theory. There are two kinds of SFRs: BSFRs (counterparts of ordinary SFRs) changing the arrow of time and SSFRs (analogs of "weak" measurements) preserving it and giving rise to the analog of Zeno effect (`https://cutt.ly/yl7oIUy`) [L70].

To avoid confusion it is good to emphasize some aspects of ZEO.

1. ZEO does not mean that the physical states identified in standard quantum theory as 3-D time= constant snapshots - assignable in ZEO to the opposite boundaries of a causal diamond (CD) - would have zero energy. Rather, these 3-D states have the same conserved quantities such as energy. Conservation laws allow us to adopt the convention that the values of conserved quantities are opposite for these states so that their sum vanishes.

   This is not new: in quantum field theories (QFTs) one speaks instead of incoming and outgoing particles of external particles coming from the geometric past and future and having opposite signs of energy. That conserved quantities vanish in the *4-D* sense, expresses only the content of conservation laws.

2. ZEO implies *two* times: subjective time as a sequence of quantum jumps and geometric time as a space-time coordinate: for instance, the proper time of the observer. Since subjective does not correspond to a real continuum, these times are not identifiable but are strongly correlated. This correlation has led to their identification although they are different.

3.2.2 BSFR as a death and reincarnation in universal sense

In BSFRs, the arrow of time is changed and the time evolution in the final state occurs backwards with respect to the time of the external observer. The BSFRs can occur at all scales since TGD predicts a hierarchy of effective Planck constants h_{eff} with arbitrarily large values. There is empirical support for BSFRs.

1. The findings of Minev et al [B2] for atomic systems can be explained by the same mechanism [L42]. BSFR replaces zero energy state with a new one and changes the roles of the 3-D states (active and passive state) at the boundaries of CD.

   For an observer with a standard arrow of time, the final zero energy state is a superposition of deterministic, smooth time evolutions leading to a fixe 3-D state at the formerly active boundary of CD. Interestingly, once this evolution has started, it cannot be stopped unless one changes the stimulus signal inducing the evolution. In this case the process does not lead to anywhere: the ZEO based interpretation is that BSFR back to the initial state occurs.

2. Libets' experiments about the active aspects of consciousness [J6] can be understood from this perspective. For instance, a subject person raises his index finger and neural activity starts *before* the conscious decision to do so. In the physicalistic framework, neural activity leads to the experience about the decision so that free will would not be real. Libet himself proposed what he called a veto option: free will is in the decision to stop the action already initiated. The problem with the veto option [J2] is that the activity beginning .5 seconds earlier looks like dissipation with a reversed arrow of time. In the standard direction of time this looks like self-organization which leads from chaotic state to ordered state at around .15 seconds before the raising of the finger. The ZEO explanation is that a macroscopic BSFR occurred and generated a signal proceeding backwards in time which generated neural activity and dissipated to randomness.

3. An example from a different scale comes from earthquakes and supports the universality. Earthquakes involve a strange anomaly: they are *preceded* by ELF radiation. One would expect that ELF radiation would follow the earthquake. In the TGD framework, the identification as BSFR can explain the anomaly [L43, L38].

   In biology, the reversals of the arrow of time may occur routinely [J24] and indeed are a central element of biological SO in the TGD framework. Time reversal also explains self-organized quantum criticality (SOQC) identifiable as the basic mechanism of homeostasis [L46, L79]. Homeostasis would occur spontaneously rather than being a result of programming.

3.2.3 Sequence of SSFRs as life cycle

SSFRs are counterparts of "weak" measurements, which are much like classical measurements and do not involve any dramatic changes. The sequence of SSFRs gives rise to a conscious entity - self - as a sequence of moments of consciousness. Subjective time as a sequence of SSFRs correlates with the geometric time for which one identification is as the distance T between the tips of CD, whose size increases statistically.

1. In SSFRs [L66] members of states at the "passive" boundary (PB) of the CD are not changed and PB itself is not shifted although it increases in size. The

active boundary (AB) recedes from PB and increases in size in a statistical sense. Also, the states at AB change by unitary time evolutions followed by SSFRs that do not affect the states at PB.

SSFRs correspond to a measurement of observables whose action does not affect the states at PB. Cognitive measurements are excellent candidates for these kind of measurements [L66]. The time T identified as the temporal distance between the tips increases in a statistical sense and correlates with the subjective time identified as a sequence of SSFRs.

2. The identification of a "geometric now" as a correlate of "subjective now" is not unique. The most natural identification of the geometric time is as the linear M^4 time coordinate assignable with the line connecting the tips of CD(see **Fig. 9**) . The "geometric now" would correspond to the $T_{now} = T/2$ which corresponds to a 3-ball at which the expansion of 3-ball with light-velocity changes to contraction - the analogy with the Big Bang followed by the Big Crunch is obvious. T_{now} increases in a statistical sense.

3. $M^8 - H$ duality predicts that the roots r_n of the real polynomial P define special moments $t = r_n$ of M^4 linear time: I have called them "very special moments in the life of self" [L20, L21, L22, L40, L62, L63]. If these moments correspond to the values of T_{now} for SSFRs, the size of CD increases in a step-wise manner.

4. The Lorentz invariant light-cone proper time a labeling the hyperboloids inside the lower and upper half-cones of the $CD \subset H = M^4 \times CP_2$ is the second natural candidate for the geometric time coordinate and is completely analogous to cosmic time. It reduces in a good approximation to t near the time axis connecting the tips of CD.

   What has been said, applies at the level of H. $M^8 - H$ duality [L62, L63] forces to consider also M^8 level. M^8 is analogous to momentum space: there is no time and space in the usual sense. Could the claims about timeless and spaceless states of consciousness correspond to M^8 mode? In momentum space interpretation a corresponds to mass and t to energy.

$M^8 - H$ duality leads to a more detailed picture about the evolution of self. One may consider first what the evolution of self looks like geometrically.

1. A given space-time surface in M^8 is determined in terms of an octonionic polynomial $P(o)$ obtained by algebraically continuing a real polynomial $P(x)$ with rational coefficients (so that p-adic variants of the space-time surface exist). $P(o)$ is decomposed to quaternion valued "real" and "imaginary" parts and the space-time surface corresponds to a root for the real part of $P(o)$ [L40, L62, L63].

   The associativity of the normal space of the space-time surface is the number theoretical dynamical principle. It implies that space-time surfaces are minimal surfaces. Also their counterparts in $H = M^4 \times CP_2$ - obtained by $M^8 - H$ duality - are minimal surfaces geometrizing the massless wave equation.

2. One can assign to the half-cones of the CD distinct polynomials which must be identical at $t = T/2$. The condition is satisfied if the polynomials are $P(o)$ for the "lower" half-cone and $P(T-o)$ for the "upper" half-cone. The space-time surfaces associated with the half-cones are in well-defined sense mirror images glued together at $T_{geom} = T/2$. This is not however the case for the space-time surfaces assignable to sub-CDs of CD interpreted as correlates of the mental images of the self assignable to CD.

This proposal has strong implications.

1. The evolution by steps consisting of unitary time evolution+SSFR increases the size of CD in a statistical sense (the number of CDs larger than given CD is infinitely larger than those smaller than it). PB remains unaffected except from the scaling. Hence the size of the region of space-time surface identified as a "root" of the real part of P, increases: more of the surface determined by P becomes visible in each SSFR. This is like opening a packet containing a gift. Each very special moment $t = r_n$ brings something new into daylight.

2. At $T_{now} = T/2$ the sensory input from the geometric past induces sensory mental images drifting to the geometric future and gives rise to memory mental images assignable to sub-CDs. Contrary to the naive expectation, these memory mental images indeed drift to the geometric future of T_{now} as the size of CD increases rather than remaining in the geometric past. The emergence of these sub-CDs in shorter scales breaks the mirror symmetry between half-cones.

   This makes it possible to learn from experiences during a given life cycle and utilize this learning during the next life cycle with an opposite arrow of time. In the BSFR the active boundary becomes passive and these memory mental images become the "silent wisdom" for the time reversed self representing what was learned during the previous life cycle.

3.2.4 ZEO and planned actions

ZEO also provides a model for planned actions. To understand the basic idea, it is good to describe first the strange finding by Armor and Sackett [J3] and its TGD based explanation.

1. Armor and Sackett made a surprising discovery: the prediction of what happens in a future event is more reliable if the person knows that the event will actually occur. The future event was a scavenger hunt and the participant had to predict her performance as the number of items to be found. The participants who knew that the event will actually take place, made better predictions.

   Did the participants precognize their performance as passive spectators of themselves in the geometric future so that free will would be an illusion? This need not be the case: the information was about the number of items found and rather abstract. This did not fix the detailed behavior of the participant in the hunt.

2. In [L84] it was shown that the finding actually fits with the vision in which BSFRs occur as cascades which proceed from long to short scales. MBs represent a hierarchy of abstractions about the lowest level. The higher the level, the less detailed the information [L60]. Only this abract information can be pre-determined.

   The BSFR for MB_2 above MB_1 in the hierarchy - the "boss" - corresponds to time scale $T_2 > T_1$ and determines the fate of MB_1 in the time scale T_2. MB_1 can apply its free will in the time scale T_1 in the limits posed by its fate. This paradoxical finding makes the distinction between subjective and geometry time very concrete. The fate of the subject person MB_1 is to some degree determined by BSFR of MB_2 that occurred *before* MB_1 made the prediction but geometrically *after* T for making the prediction.

   Also the idea of the organizer of the experiment to perform the experiment was actually communicated by MB_2 to the experimenter and she only realized her fate.

Could most, if not all, planned actions be like this - induced by BSFR in the geometric future but in subjective past and allowing planning of the details? There would be the experiences of planning and a realization induced by the signals from the geometric future by a higher level in the hierarchy of conscious entities predicted by TGD! In long time scales we would be realizing our fates or wishes of higher level conscious entities rather than agents with completely free will.

1. Ordinary matter is at the bottom of the master slave hierarchy and its coherence is forced by the quantum coherence at higher levels of the layers of MB.

2. BSFR for a higher level MB gives rise to what is experienced as a planned action at the lower levels of the hierarchy. Planned action at a given level induces a cascade of planned actions in shorter time scales which eventually proceeds to atomic level.

3. Sensory perceptions naturally correspond to SSFRs ("weak" measurements (`http://tinyurl.com/zt36hpb`), and both BSFRs and SSFRs can occur with both arrows of time. Also motor action would be a cascade of BSFRs with each BSFR inducing sensory perceptions as SSFRs at lower level inducing in turn motor actions as BSFRs in shorter time and length scales. The above model generalizes the notion of motor action.

3.3 Negentropy Maximization Principle (NMP) as a variational principle of consciousness

Negentropy Maximization Principle (NMP) defines the variational principle of consciousness in TGD [K7] [L76].

1. The NMP replaces second law (SL) and implies it for ordinary matter. SFR means a reduction of the entanglement for a pair $S_a - S_b$ of sub-system S_a and

S_b its complement in S. Measurement cascade proceeding from long to short scales decomposes at each step a system to a pair of unentangled subsystems is in question. NMP states that negentropy gain in these reductions is maximized and selects the pair $S_a - S_b$ at given step.

2. In adelic physics [L23, L25] the entropy $N = -S_1 - S_2$ is the sum of real and various p-adic negentropies. p-Adic negentropies can be positive so that for non-trivial EQs one can have $N > 0$. Negentropic entanglement (NE) is stable against NMP so that the process stops. It is natural to assign positively colored emotions to NE and it distinguishes between living and inanimate matter and also between dark and ordinary matter.

3.3.1 NMP as a generalization of the second law of thermo-dynamics

Jeremy England [I8] has proposed on the basis of empirical facts that somehow SL implies evolution. This statement is in conflict with the standard thermodynamical view of biology. This vision is discussed from TGD point of view in [L12].

NMP [L76] explains why England's paradoxical view is true. England would be however wrong in believing that SL implies evolution. A generalization of quantum measurement theory to a ZEO based theory of consciousness, and a number theory based view about cognition leading to adelic physics, is needed.

1. SFR decomposes a given system (unentangled from environment) to 2 subsystems in such a manner that the negentropy gain is maximal for the the "winning" decomposition. This corresponds to a quantum measurement of a universal observable identified as the density matrix for the subsystem-complement pair.

2. TGD allows a genuine notion of negentropy assignable to the entanglement and thus to the density matrix. The negative of ordinary entanglement entropy $N = -S$ defines negentropy is at best is $N = 0$, usually N is negative.

   A genuine measure of information is needed. Since information is associated with cognition, one must expand the realm of physics to include cognition. One can assign also to the extensions of p-adic number fields entanglement entropy by the analog of Shannon formula replacing logarithms of probabilities with the logarithms of their p-adic norms [K7] [L76].

   The positive news is that the p-adic entropy can be negative and has a magnitude not smaller than the real entropy. Therefore the negentropy identified as the sum $N = -S_1 - S_2$ of real and p-adic entanglement negentropies can be positive for non-trivial EQs. N defines a genuine measure of information and by NMP increases during the life span of the conscious entity. This however implies the increase of real entanglement entropy [L12].

   p-Adic number fields combining with real numbers to form adele are needed [L23, L25]. Also algebraic extensions of p-adic number fields induced by EQs and forming an infinite hierarchy with an increasing complexity identifiable as evolutionary hierarchy are needed and emerge from $M^8 - H$ duality [L62, L63]. Space-time regions are determined by polynomials defining the EQs via their roots. Evolution as an increase of extension of rationals (EQs) is unavoidable.

3. Consider now the connection with thermo-dynamics. When SFR occurs, entanglement entropy becomes zero but ensemble entropy increases since the outcome of measurement is not deterministic and reduction probabilities correspond to the eigenvalues of the density matrix. This means the increase thermo-dynamical entropy and generation of disorder.

   However, if the SFR cannot occur, entanglement is stable. For the negentropic states for which negentropy cannot decrease, NMP prevents SFR! The negentropic states approach cognitive fixed points replacing thermodynamical equilibria for which entanglement negentropy is maximum. The conscious entity maximizes its knowledge during its life-span quite universally: this applies to all systems in all scales, not only to humans.

   For the ordinary matter NMP is trivial. Entanglement can be non-negentropic also non-trivial EQs. In these cases NMP does not prevent complete de-entanglement from occurring and SL holds true. For dark matter with $h_{eff} > h$ NMP can however stabilize entanglement and this gives rise to a generation of conscious information. To sum up, the pessimistic SL transforms to an optimistic NMP and implies SL for the ordinary matter.

4 TGD and quantum biology

Problems have served as starting points for developments in TGD. This applies also to biology. The following list includes only some of them. A more detailed discussion is in [L37].

1. How can we understand the coherence of living systems? If only bio-chemistry were involved, we would be sacks of water with some chemicals added. Sacks of water do not climb in trees or write poems. Could quantum coherence induce the coherence? What entity serves as intentional agent and how it could realize its intentions?

2. Why is metabolism needed? Particles with nonstandard h_{eff}/h_0 have higher energy as a rule. Is metabolic energy needed to excite particles to dark states and thus to increase their "IQ"? Could evolution be seen as an increase of $h_{eff}/h_0 = n$ as the dimension of EQ forced by the fact that the number of extensions with dimension larger than a given integer n is infinite and those with dimension smaller n is finite?

3. Is the genetic code (GC) totally accidental? Could the biochemical realization of the GC only be a mimicry of a deeper level of the GC?

4. What is morphogenesis? If biology is mere biochemistry, it is difficult to answer this question. If space-time topology is non-trivial in all scales, situation changes dramatically. All structures - including bio-molecules, membrane like structures, organelles, organs, ... - are 4-D space-time surfaces representing dynamical patterns, and morphogenesis emerges at classical level [L36, L14].

The model for living matter relies heavily on the notions of MB carrying $h_{eff} > h$ phases behaving like dark matter and ZEO.

4.1 MB carrying dark matter as controller of ordinary biomatter

MB would contain dark matter identified as phases of ordinary matter characterized by EQ with a dimension $h = h_{eff}/h_0 = n$ measuring algebraic complexity of space-time region [L54, L55] and interpreted as a universal IQ. The scales of quantum coherence increase with h_{eff}. The layers of MB characterized by the value of n naturally form a slaving hierarchy in which ordinary matter with the smallest Planck constant is at the bottom and controlled by higher levels. The energies of systems increase with h_{eff} and since h_{eff} tends to be spontaneously reduced, energy feed is needed to preserve the distribution of h_{eff}: the interpretation is as a metabolic energy feed.

MB acts as a "boss" controlling ordinary matter and induces self-organization [L46].

4.1.1 Anatomy of MB

MB has as its body parts magnetic flux quanta: flux tubes and flux sheets. There are two kinds of flux quanta. Flux can be vanishing, which corresponds to the Maxwellian case. Flux can also be non-vanishing and quantized corresponding to a the monopole flux. In monopole case, the magnetic field requires no current to create it. This option is not possible in the Maxwellian world. These flux tubes play a key role in TGD Universe in all scales.

Also the Earth's magnetic field with nominal value $B_E = .5$ Gauss has two parts.

1. The monopole part corresponds to the "endogenous" magnetic field $B_{end} = .2$ Gauss explaining the strange effects of ELF em radiation to the physiology and behavior of vertebrates [J10]. The presence of this part identifiable as monopole flux explains why Earth has a magnetic field. This field should have decayed long time ago in a Maxwellian world since it requires currents to generate it and they disappear. Also the magnetic fields of permanent magnets as opposed to electromagnets could have a monopole part consisting of flux quanta.

2. The interaction of MB with the gravitational field of Earth is discussed in [L78]. Intriguingly, the metabolic energy currency with the nominal value of .5 eV is rather near to the energy for the escape velocity of proton. The transfer of ions from the surface of Earth to MB would be a standard process and indeed require metabolic energy.

4.1.2 Communications to and control by MB

Communication from the biological body (BB) to MB and its control by MB would rely on dark photons, which can transform to ordinary photons with large h_{eff} and vice versa. Molecular transitions would represent one form of control.

1. Cell membrane could act as a generalized Josephson junction generating dark Jophson radiation with energies given by the sum for ordinary Josephson energy and of the difference of cyclotron energies for flux tubes at the two sides

of the membrane. The variation of the membrane potential modulates the Josephson frequency and codes the sensory information at cell membrane to a dark photon signal sent to MB.

2. The large effects of radiation at ELF frequencies observed by Blackman and others [J10] could be understood in terms of the cyclotron transitions in $B_{end} = .2$ Gauss if "h" in $E = hf$ is replaced with h_{eff}, which should be rather large and possibly assignable to gravitational flux tubes with $\hbar_{eff} = \hbar_{gr} = GMm/v_0$. For the simplest model, M represents the Earth's mass coupling to the small mass m, and v_0 is a parameter with dimensions of velocity. The energies $E = h_{eff}f$ of dark photons should be in the biophoton energy range (visible and UV) characterizing molecular transitions [K14, K15].

   $v_0/c \simeq 2^{-11}$ suggested by the Nottale's model for planetary orbits [E1] the predicted cyclotron frequency scale is 3 orders of magnitude higher than the energy scale of visible photons. For $v_0/c \leq 1$ at the surface of Earth this problem disappears. I have also considered the replacement $M \to M_D < M$ with M_D representing dark matter portion of M or the replacement $G \to G_D < G$ but these options do not seem plausible [L77, L72].

   MB would control BB by cyclotron radiation - possibly via genome accompanied by dark genome at flux tubes parallel to the DNA strands. Cyclotron Bose-Einstein condensates of bosonic ions, Cooper pairs of fermionic ions, and Cooper pairs of protons and electrons would appear as dark matter in living systems and the $h_{eff} = h_{gr}$ hypothesis predicts a universal cyclotron energy spectrum in the range of bio-photon energies.

3. Dark photons would transform to bio-photons [L7, L6] with energies covering visible and UV energies associated with the transitions of bio-molecules. The control by dark photons implies that remote mental interactions are routine in living matter. EEG would represent a particular instance of these communications: without the MB it is difficult to understand why the brain would use such large amounts of energy to send signals to outer space.

4. In ZEO, field body (FB) and MB correspond to 4-D rather than 3-D field patterns and quantum states correspond to quantum counterparts of behaviors and biological functions. Conscious holograms could be generated as interference of a dark photon reference beam from MB and a dark photon beam carrying the sensory information. This hologram would be read by MB using the conjugate of the reference beam.

   In the ZEO also the time reversals of these processes take place. This makes possible to understand memory as communications with memory mental images in the manner already explained.

4.1.3 Evidence for dark charged particles

The notion of dark matter as controller of biomatter emerged before its number theoretic justification.

1. The values of $h_{eff} = nh_0$ must be so large that the energies $E = h_{eff}f$ of dark photons with EEG frequencies are in the biophoton energy range (visible and UV) characterizing molecular transitions [K14, K15].

2. What makes possible the large values of h_{eff}? Nottale's hypothesis [E1] introduces the notion of the gravitational Planck constant $\hbar_{gr} = GMm/v_0$. In the TGD framework $h_{eff} = h_{gr}$ is assigned to gravitational flux tubes [L39]. There are non-trivial implications reflecting the Equivalence Principle (EP).

   (a) The cyclotron energy spectrum $E_c = n\hbar_{gr}eB/m = nGMeB/v_0$ does not depend on the mass m of the charged particle and is thus universal. The energies involved are proposed to be in the range of biophoton energies (at least) suitable for control of the transitions of the bio-molecule.

   (b) The gravitational binding energies of mass m for Bohr orbits around M do not depend on M at all [L78].

Also relatively small values of h_{eff} are possible.

1. Electrons can also have dark phases, but now the value of h_{eff} would be much smaller and satisfy the generalized Nottale hypothesis $h_{eff} = h_{em}$, where h_{em} is the electromagnetic analogue of h_{gr} assignable to flux tubes accompanying valence bonds. This inspires a model of valence bond [L68] (`https://cutt.ly/5f5QrgF`) predicting that the value of $h_{eff}/h_0 = n = h_{em}$ increases along the rows of the periodic table.

   This picture can explain why the molecules such as proteins containing atoms towards the right end of the rows are ideal carriers of metabolic energy and why ions like Ca^{++} involved with the control of cell membrane and having very large h_{eff} are towards the left end of the rows.

2. The energy scale of dark variants of valence electrons is proportional to $1/h_{eff}^2$ so that the orbital radii are scaled up and the identification as a Rydberg atom is the only possibility in the standard physics picture: could dark valence electrons be in question? There is empirical evidence, known for decades, for the mysterious disappearance of valence electrons of some rare earth metals. The article "*Lifshitz transition from valence fluctuations in YbAl3*" by Chatterjee et al published in Nature Communications [D1] discusses this phenomenon for Yb.

   The finding [D2] about "misbehaving" Ruthenium atoms also supports the view that covalent bonds involve dark valence electrons. Pairs of Ru atoms were expected to transform to Ru dimers in thermo-dynamical equilibrium but this did not happen. This suggests that valence electrons associated with the valence bond of Ru dimers are dark in the TGD sense and the valence bonded Ru dimer has a higher energy than a pair of free Ru atoms.

   The TGD based explanation [L28] could be justified by a resonant coupling of the dark electron with an ordinary Rydberg state of the valence electron. In the lowest approximation, dark valence electrons have energies in the spectrum of ordinary valence electrons so that a resonant coupling with Rydberg states

can be considered. The evidence found by Randell Mill [D3] for atoms with an abnormally large scale of binding energy suggests the formula $h = 6h_0$ [L27]. Atomic binding energies are proportional to $1/h_{eff}^2$ and Mills reports that binding energy scale can be 4 times larger than for ordinary atoms. This would correspond to $h_{eff} = h/2$.

4.1.4 Pollack effect

In the Pollack effect [I9] negatively charged exclusion zones (EZs) are induced at the boundary between the gel phase and water by an energy feed such as IR radiation. The negative charge of EZs is explained as a formation of flux tubes carrying dark protons having an interpretation as dark nuclei. Every 4^{th} proton would transform to a dark proton at flux tubes.

A simple model for linear dark proton triplets predicts their states to be in a 1-1 correspondence with DNA, RNA, tRNA, and amino-acids and the numbers of codons coding for given amino-acid are predicted to be same as for vertebrate genetic code [L32, L45]. This means deep connections between nuclear physics and condensed matter physics, chemistry, and biology usually thought to be disjoint disciplines.

EZs are able to remove impurities from their interior in conflict with second law (SL). The TGD based explanation is that the time reversal by BSFR at the level of MB [L70] induces effective time reversal also at the level of ordinary bio-matter.

DNA has one negative charge per nucleotide, microtubules are negatively charged, also the cell is negatively charged, and ATP carries 3 units of negative charge. Therefore ZEO suggests that the Pollack effect plays a key role in bio-control and macroscopic SFRs play a key role in living matter.

4.1.5 Basic differences between organic and in-organic matter

One of the basic differences between organic and in-organic matter would be the presence of dark protons and electrons.

1. The notions of acids and bases would reduce to the presence of dark protons: pH would characterize the fraction of dark protons. The notion of reduction and oxidation (REDOX reaction) would reduce to dark electrons associated with valence bonds [L82] (`https://cutt.ly/5f5QrgF`).

2. In biochemistry the density of dark protons would be much higher in Pollack effect [I5, I6, I1, I9, I13]. Also dark ions would be important in biochemistry, at least positively charged ions would have a key role in TGD based view about biochemistry.

4.1.6 Biocatalysis and water memory

Bio-catalysis and water memory remain mysteries in the bio-chemical approach. MB carrying dark matter could provide the needed mechanisms. Reconnection of flux tubes would be the basic element of bio-catalysis and also explain water memory.

1. According to the TGD view of catalysis, the tentacle-like U-shaped flux tubes associated with MBs of reactants reconnect to a pair of flux tubes connecting the molecules [L35]. This happens if there is a cyclotron resonance for dark cyclotron radiation assignable to massless extremals (MEs) associated with these "tentacles"". This requires that the flux tubes have identical magnetic field strengths and - by flux quantization - the same thickness. The same value of h_{eff} guarantees resonance. The next step is the shortening of the "tentacles" by a reduction of h_{eff} and liberation of energy which "kicks" the reactants over the potential wall making possible the otherwise extremely slow process.

2. The physics of water is plagued by anomalies [I12]. TGD suggests an explanation [L31] in terms of flux tubes assignable to hydrogen bonds [L31, L34]. These flux tubes could have $h_{eff} > h$ so that these flux tube could be long and give rise to long range quantal correlations. Water could be seen as a many-phase system. MBs assignable to water molecule clusters could mimick the cyclotron frequency spectrum of the invader molecule and make possible water memory and a primitive immune system based on reconnections of the "tentacles" of water cluster and invader molecule [L59]. In this framework water would represent a primitive life form.

4.2 Adelic physics, cognition, and biology

$M^8 - H$ duality [L47, L54, L55] concretizes the number theoretic vision.

1. $M^8 - H$ duality states the representability of space- times as a 4-D surfaces in either complexified M^8 (complexified octonions O_c) or $H = M^4 \times CP_2$. $n = h_{eff}/h_0$ has interpretation as dimension of EQ identifiable as the degree n of the polynomial determining the space-time surface in M^8. Roots correspond to different sheets of n-sheeted space-time surface, and the Galois group G of EQ permutes the sheets with each other and act as a number theoretic symmetry group. Dark matter states at the flux tubes would are representations of G.

2. The wave functions in the set of space-time surfaces obtained by the action of G have interpretation as functions in G defining the group algebra $L(G)$ of G. They define quantal cognitive representations. Also their fermionic counterparts make sense. Galois group G would thus act as the symmetry group of cognition. The notion of cognitive measurement in $L(G)$ makes sense and leads to a model of cognitive process as a cascade of cognitive SSFRs [L66, L76].

3. Galois confinement [L59] would force n-particle states to behave as a single unit like hadrons do as color-confined states.

4. The model makes rather far-reaching predictions. For instance, simple groups are groups having no normal subgroups [L76, L74]. The decomposition of EQ to an extension of extension of ... of EQ defines a hierarchy of normal subgroups which in turn makes it possible to express the element of $L(G)$ as entangled products of states in the group algebras associated with

the normal subgroups. For simple groups, whose classification is known, this decomposition is by definition trivial. Cognitive processes as SSFR cascades are impossible for simples Galois groups - thinking as analysis is impossible. Could simple groups classify meditative states/irreducible ideas?

4.3 Gentic code (GC)

The model of bio-harmony [L9, L10, L45, L56] is essential for understanding of what might be called emotional intelligence and its relations to the ordinary intelligence.

1. Bioharmony is based on the icosahedral and tetrahedral geometries and predicts that genetic codons correspond to dark photon triplets (3-chords of light). The representation of the 12-note scale as a sequence of quints reduced by octave equivalence fixes the harmony for a given Hamiltonian cycle and realizes the symmetries of the harmony defined by some subgroup of the icosahedral group.

   The combination of 3 icosahedral harmonies with 20 chords and having different symmetries with tetrahedral harmony with 4 chords gives bioharmony 20+20+20+4=64 chords assigned to DNA codons. The counterparts of amino-acids are identified as orbits of 3-chords under the symmetries of a given harmony, and one obtains 20 amino acids. DNA codons coding for a given amino acid correspond to the chords at the corresponding orbit and the numbers of DNA codons coding for a given amino acid come out correctly, which is something highly non-trivial.

2. Bio-harmony assigns the binary aspects of information to the 6 bits of codon and emotional aspects to the bio-harmony characterized by allowed chords fixed by a given Hamiltonian cycle at icosahedron and the unique tetrahedral cycle.

   The model of bio-harmony requires that the values of B_{end} correspond to those associated with Pythagorean scale and defined by quint cycle. These frequencies correspond to energies that a molecule must have in order to serve as a candidate for a basic biomolecule.

3. In the second model of GC [L32] codons as dark proton triplets. The numbers of dark proton triplets correspond to numbers of DNA, RNA, tRNA codons, and amino acids and one obtains correctly the numbers of DNA and RNA codons assignable to given amino-acid in the vertebrate GC. Genes would correspond to sequences of dark proton triplets [L45]. Dark proton triplet - codon - would be analogous to baryon and Galois confinement [L59] would force it to behave like a single quantum unit. The N dark codons of dark gene would in turn bind to Galois confined states of the Galois group of extension of the extension associated with the sequence of codons.

4. Galois confinement can be realized also for the dark photon triplets as representations of genetic codons and also for the sequences of N dark-photon representing genes as dark 3N-photon states. Genes could serve as addresses

in the communications based on dark $3N$-photon resonances. For communications between levels with the same value of h_{eff} there would be both energy and frequency resonance and for levels with different values of h_{eff} only the energy resonance. It is an open question whether for dark-ordinary communications dark photon $3N$-plets transforms to single or $3N$ ordinary photons (biophotons).

5. The basic hypothesis is that both DNA, RNA, tRNA, and amino acids are paired with their dark analogs, and that energy resonance mediates the interaction between the members of pairs.

Gluing icosahedron and tetrahedrons together looks aesthetically unappealing. Why is this? Surprisingly, both icosahedrons and tetrahedrons appear in perhaps the simplest honeycomb of the hyperbolic 3-space H^3 (cosmic time = constant hyperboloid) central not only in TGD but also in special relativity and cosmology [L73]. Dark GC would be realized for this particular tesselation and be universal. This tesselation would induce representations of the code at magnetic flux tubes and -sheets. Also higher than 1-D representations of GC (cell membranex and microtubules?) are possible [L75]

5 TGD based view about brain

The TGD based view of the brain differs in several ways from the standard neuroscience model [K6, K5]. The notion of MB as a controller of BB (biological body) forces to give up the idea about brain as the seat of consciousness. In addition, the view of the role of nerve pulses is radicallly different.

5.1 MB and brain

In the TGD framework, the onion-like hierarchical structures of the MB of the brain would correspond to brain regions providing an abstracted map of brain. The structure of MB with levels labelled by EQs characterized partially by $n = h_{eff}/h_0$ measuring the scale of quantum coherence, would also reflect the geometric and topological structure of the brain.

5.1.1 MB as a hierarchy of abstractions

There is evidence that functionally similar neurons can be modelled using statistically determined hyperbolic geometry [J15]. Functionally similar neurons not necessarily physically near to each other physically would be near to each other in the effective hyperbolic geometry.

MB could realize this hyperbolic geometry quite concretely as an abstract representation of the hierarchical functional structure of the brain [L60]: functionally similar neurons and also higher level structures would be connected to nearby points at the MB by flux tubes. Classification, visualizable as putting similar things in the same box, is a basic cognitive function and the hierarchy of MBs could realize classification geometrically.

There is an astonishing finding supporting the notion of MB. The neurons of the brain of a salamander were shuffled like a pack of cards. The salamander however recovered and preserved its memories (identified as learned behaviors) [J28]. In [K13, K8] this finding was considered as a support for the view of the brain as an analog of a hologram (for the idea about TGD Universe as a conscious hologram see [K2]). It is, however, clear that a single neuron cannot represent the information content of the entire brain. However, if memories are represented by the images of neurons at the level of the MB, the shuffling of neurons has no effect on memories as indeed found. Neurons would be the analog of RAM in computer science.

5.1.2 Dark photons and communications and control

Communications both inside the CNS and also from ordinary cells, could occur by dark cyclotron photon signals with $h_{eff}/h = n$ and light velocity. The value of h_{eff} could be considerably smaller than for the EEG communications from the CNS to the large part of the MB. The value of h_{eff} could be estimated from the scaling up of cell length scale to a typical scale in CNS. This iteration of back-and-forth communications makes possible pattern completion and recognition leading to standardized perceptions as near as possible to the sensory input and representing only the essential features of the sensory input.

Dark photons could transform in an energy conserving manner to biophotons with energies in the visible and UV range (at least) and thus above thermal energy and therefore having effects not masked by thermal radiation. The brain is known to emit biophotons and they are also associated with axons [K15, K14].

Dark Josephson radiation would make information transfer to MB possible whereas the control signals from the MB would be as dark cyclotron photons. **Fig. 11** illustrates the communication of sensory data to the "big" part of MB as dark photons.

1. Nerve pulse patterns modulate generalized Josephson frequencies for the flux tubes associated with the membrane proteins (ion channels and pumps, etc...) which act as generalized Josephson junctions. The sensory input is encoded by the Josephson radiation sent to the "large" part of MB [K3].

2. The frequency modulated Josephson radiation generated by nerve pulses would give rise to EEG (and perhaps also to its scaled variants) as a communication of information from the brain to MB via Josephson frequency modulation. The size scale of this layer of the MB would be rather large, of the order of c/f_c, and given by the circumference of the Earth for Schumann frequency $f_c \sim 7.8$ Hz. The structure of the Earth's magnetosphere suggests that both EEG bands and regions of BB correspond to regions of magnetosphere [L72].

3. Nerve pulse patterns would code for information communicated to various layers of MB assignable to the EEG bands as a frequency modulated generalized Josephson radiation. Generalized Josephson frequency would be the sum of the ordinary Josephson frequency $f_J = ZeV/h_{eff}$ and the difference of cyclotron frequencies $f_c = ZeB/2\pi m$ for flux tubes at different sides of the neuronal membrane and transversal to it. The modulation of f_J by the nerve pulse patterns [K9, K3, K10] would code for sensory and cognitive information.

4. The frequency modulated dark photon radiation absorbed in cyclotron transitions at MB would generate a sequence cyclotron resonances at MB and code sensory input. Already the modulation of membrane potential at the basal ganglia of sensory receptors could communicate sensory information in this manner. If so, nerve pulse patterns could be a secondary representation of sensory information induced by the sequence of resonance peaks from MB back to brain. This picture applies also to other forms of information (there are also basal ganglia inside the brain).

   The dual representations of sensory information as resonance peaks and continuous Josephson radiation would be analogous to the local representation of a function provided by its values for a discrete sequence of time values, and to the holistic representation provided by its Fourier transform for a discrete set of frequencies.

MB controls BB and the motor output generated by the control signals from MB would be as "negative energy" signals with a reversed arrow time: two BSFRs are required to re-establish the original arrow of time. The motor output of MB could take place via genes and induce gene expression as proteins. Also other forms of gene expression such as as dark photon signals to the cell-/neuronal membrane inducing nerve pulse patterns building connected "wave guides" along which the dark photon signals representing motor output can propagate.

The number theoretic vision suggests a considerable generalization of the idea about resonant communications [L82]. The model of Galois confinement (GC) based on the notion of bio-harmony [L9, L10, L58, L73] and the notion of GC [L66] suggests that dark 3N-photon states function as coherent dynamical units and are analogs of Bose-Einstein condensates. This generalizes the notion of resonance to 3N-resonance. Genes could be represented as sequences of N dark photon "3-chords" serving as addresses in dark 3N-photon communications [L58, L73]. For a model of human language based on this picture see [L80, L81].

5.2 A new view about sensory perception

The identification of sensory organs as seats of sensory qualia and new a view of the role of nerve pulses distinguish between the standard view of neuroscience and the TGD view.

5.2.1 Sensory organs as seats of sensory qualia

According to TGD view, sensory perception generates sensory mental images at sensory organs rather than in the brain [L33]. This could solve the basic problem of neuroscience due to the similarity of neural tissue in various sensory areas. The phenomenon of phantom limb - that is pain in a non-existing limb - is the basic objection. The new view of time and memory implied by ZEO would solve this problem: the pain in the phantom limb would be a sensory memory of pain.

This view would solve several mysteries of neuroscience. The stimulation of temporal lobes indeed generates sensory memories, and people with a cognitive impairment are known for memory feats such as being able to draw a building seen in the past with every detail or to learn music pieces with single listening.

1. These feats can be understood if the sensory memories and memories in general correspond to "seeing" in time direction.

2. The first guess would be that a beam of dark photons travels to the geometric *past* and is reflected back to produced memories as analog of sensory perception. Memories would be in geometric past. However, on further consideration, the process seems to be more complex.

   It is possible to build a rather detailed model for sensory memories [L64, L65] based on ZEO, the notion of CD (see **Fig. ??**) as perceptive field of self at the level of imbedding space, and the identification of the geometric correlate of the "subjective now" (T_{now}) as the 3-ball along which the half-cones of CD are glued together. Memories as mental images would correspond to sub-selves assigned to sub-CDs residing in the *geometric future* of T_{now} and shift to geometric *future* during the sequence of SSFRs defining self and increasing the size of the CD and value of T_{now}. In the BSFR, identified as the death of self in universal sense, these memories would become "silent wisdom" for the next life cycle with opposite arrow of time.

5.2.2 New view about the role of nerve pulse transmission

Since perception is not mere passive reception of sensory input but involves pattern recognition building standardized mental images, the TGD based view about sensory organs requires forth-and-back signaling between the brain and sensory organs. There should be a virtual sensory input from the brain or from MB via the brain to sensory organs. Sensory percept would be an artwork, a standardized mental image, which is as near as possible to the sensory input. Pattern recognition would occur when the constructed pattern is sufficiently near to a standardized mental image.

The velocity of nerve pulse conduction is too slow to build a standardized sensory mental image by fort-and-back signalling. Nerve pulse duration of order 1 ms defines the lower bound for the time for the duration of the synaptic "bridge" making possible the propagation of dark photon signal. For 10 cm long neural pathway this duration allows about 10^6 forth and back travels of light for a signal between sensory cortex and the retina.

The TGD view about sensory perception and the function of the nerve pulse transmission differs from the standard view. Nerve pulse conduction would not be communication between parts of the CNS but building of communication lines for dark photons, which would propagate with maximal signal velocity [L33] [K9]. Nerve pulse patterns at the level of the brain would build standardized cognitive representations by decomposing the sensory input to "named" objects of a perceptive field to build associations.

Sensory organs are seats of sensory qualia and sensory perception requires feedback from the MB and brain to sensory organs as a virtual sensory input as dark photons in order to build standardized mental images - the process is essentially pattern completion and recognition [L33]. The model explains REM dreams, hallucinations, and psychedelic experiences as experiences involving only the virtual input. Imagination can be understood as almost sensory experience.

More concretely:

1. Sensory mental images at sensory organs can be generated by an iteration involving the virtual sensory input from the brain to the sensory organs. Pattern recognition is realized as a build-up of an artwork representing standardized mental image as near as possible to the original sensory input. **Fig. 11** illustrates the forth-and-back communications of sensory data between sensory organ and brain using dark photons.

2. Nerve pulses would connect existing flux tube connections parallel to axons: neurotransmitters at synaptic contacts would act as relays. There is an analogy with an old fashioned telephone network: it would be energy consuming to keep the connections on all the time.

3. The standard view about learning as a strengthening of synaptic connections translates into a gradual build-up of permanent flux tube connections. Thus communications with dark photon signals would be possible all the time. This could lead to the fusion of the sender and receiver to a single quantum entangled system.

4. Actually all information molecules (neural transmitters, hormones, messengers) could be connection builders. I have discussed this idea earlier in a slightly different form: the proposal was that information molecules are attached to the end of a flux tube, which stretches as the molecule travels to its target.

   The view of neuroscience might be very different tod if information technologies had been known a century ago. The same applies to water memory [K4], which still remains a dismissed concept in mainstream science, although a lot about the mechanisms involved is known.

5.2.3 Dreams, hallucinations, and imagination

TGD allows to understand imagination as virtual sensory inputs *resp.* motor actions from MB via brain which do not reach actual sensory organs *resp.* muscles. Virtual seensory inputs are received by virtual sensory organs inside brain for which a good candidates are basal ganglia - ganglions are also associated with sensory receptors. Imagination is almost sensory experience/motor action with input from MB or brain represented as dark photons.

The notion of virtual sensory input is central for the understanding of speech comprehension and also inner speech. Dreams (REM), hallucinations, psychedelic experiences, and dreams and motor activities during sleep could be understood as virtual sensory (motor) input reaching the sensory organs (muscles). Also memory recall could involve virtual (real in the case of sensory memories) sensory input from MB at which memory mental images are realized [L70] [L40].

The meridians of acupuncture network correspond to a permanent flux tube network and would not require nerve pulses, transmitters, nor information molecules. For CNS this flux tube network would be dynamical.

Pineal gland - the "third eye" - carries pigments like retina and serves as an eye for some animals. Could it function as an eye also for us? For instance, could visual imagination use pineal gland as eye? Could pineal gland make possible visual

experiences during NDE when a virtual sensory input to sensory receptors as in case of REM sleep does not look plausible.

A feedback loop between MB and pineal gland could in principle make building of the sensory perceptions by a feedback loop possible. Also auditory inputs from right and left combine to single perception. Pineal gland has the unique property that it has no division to left and right parts. Could it act as a central unit integrating right and left visual and auditory perceptions?

5.3 Memories

To understand what memories and memory recall could be in ZEO one must specify what the geometrical correlate of "subjective now" is?

1. "Geometric now" corresponds to the $T_{now} = T/2$ slice of CD (see **Fig. 9**) with maximal size located in the middle of the CD. If one accepts $M^8 - H$ duality [L47] "geometric now" corresponds to a "special moment in the life of self" [L47, L69] identifiable as intersection of space-time surface and 6-sphere which is brane-like entity (branes are encountered in M-theory) appearing as universal special solutions of algebraic equations determining the space-time surfaces in M_c^8. The values of T_{now} correspond to the roots of the real polynomial defining the space-time surface.

2. During the sequence of SFRs the active boundary of CD shifts towards the geometric future and the size of CD increases (in statistical sense). The sub-CDs accompanying sensory and other mental images shift to the direction of geometric future as CD increases and become potential memory mental images experiencing BSFRs in a shorter time scale.

   The time=constant snap-shots at the upper half of CD assignable to the memory mental images are ordered with respect to the Minkowski time t but the order is opposite to that for the subjective experiences. They correspond to subselves to which memory recall builds a connection by entanglement quantally or by sending a signal, which is reflected back in BSFR for the memory mental images.

What about recall of episodic memories in ZEO?

1. Spontaneous memory recall could correspond to a death of a memory mental image with an opposite arrow of time and re-incarnation with the same arrow of time as self. This would be accompanied by emission of a past directed "negative energy" signal received by self associated with the moment "geometric now". The interpretation is in terms of extraction of metabolic energy: memory recall indeed requires metabolic energy.

   Active memory recall could correspond to a receival of future directed "positive energy" signal coming from "geometric now" having interpretation as metabolic energy feed. Energy conservation would force the memory mental image to change the arrow of time.

2. The prediction is that in active memory recall by a "positive energy" signal received by the memory sub-CDs (see **Fig. 9**), the order of recalled memories is opposite to that for the real experiences. There is evidence for this kind of change [J25] (see also the popular article "*The human brain works backwards to retrieve memories*" at `http://tinyurl.com/y7hbqmug`).

6 Aging and death from TGD point of view

In the sequel the vision that aging and death are universal phenomena and that death is followed by a reincarnation with reversed arrow of time is discussed.

6.1 Aging as approach of MB and BB to thermal equilibrium

The book "Lifespan" by Sinclair and LaPlante [I3] inspired an article about aging written together with Reza Rastmanesh [L83]. The book proposes that aging corresponds to the approach to epigenetic chaos. The book also proposes that bioinformation is not only associated with DNA and GC but the conformational degrees of DNA and these are crucial in epigenesis. This vision serves as the starting point of TGD inspired view.

In adelic physics NMP [L76] replaces SL but implies SL for ordinary matter. MB carrying dark matter controls the dynamics and its quantum coherence induces the coherence of ordinary biomatter as forced, non-quantum, coherence. ZEO predicts the occurrence of time reversal in BSFR. The dissipation of a subsystem with a reversed arrow of time looks like SO from the point of view of the system. Also self-organized quantum criticality (SOQC) difficult to understand in ordinary thermodynamics becomes possible.

The basic idea is that at birth the temperatures of MBs of information molecules are very low but gradually approach the physiological temperature near Hagedorn temperature [B1] defining the maximal temperature of MB. The thermalization leads to epigenetic chaos implying that the flux tubes carrying dark DNA and therefore also DNA become loopy. The control of methylation and other modifications and their reversals crucial for epigenesis is lost. In particular, demethylation fails and leads to hyper-methylation of the promoter regions of genes. This leads to the failure of the control of genes coding for housekeeping proteins and eventually the system suffers a crash down.

6.2 What death as BSFR looks like to an outsider?

Denote by T the moment of geometric time associated with BSFR of dying system. How outsider to the system having opposite arrow of time sees the situation before T and after T?

6.2.1 Death as seen by outsider before moment T

T can be larger than the geometric time of the observer O defined as "geometric now" so that the death already taken place with respect to the subjective time of

O occurs(or is located) in the geometric future of O.

The time evolution with an opposite arrow of time allows classical signals which propagate to the geometric past. This could explain the reported strange events preceding the death of a close relative or a friend. In brain science the analog for this is what happens in Libet's experiments involving active aspects of consciousness [J6]. Brain receives a time reversed signal arriving from the geometric future interpreted in the standard pictureas readiness potential.

Although BSFR is a discontinuous change with respect to subjective time, ZEO implies that observer sees BSFR as a continuous and deterministic time evolution leading to death as the outcome of BSFR, which is actually an initial state of a time reversed time evolution (actually a superposition of classical time evolutions).

Dissipation in the reversed arrow of time is one particular thermo-dynamical anomaly involved with BSFR. For O this looks like SO and generation of gradients, in particular extraction of energy from the environment manifesting itself as a cooling of the environment. It might be possible to test this prediction.

6.2.2 Death as seen by an outsider after moment T

The life of the reincarnate continues with a reversed arrow of time to the geometric past increasing the CD in an opposite direction of time (see **Fig. ??**). What about the region of space-time surface complex in $H = M^4xCP_2$ in the future of the CD for which BSFR has occurred?

The experience with the death of the ordinary life forms suggests an answer. What outsiders see is the decaying organism. The interpretation is that the highest layer of the onion-like MB is absent and does not continue its control in the original time direction. The ship has "lost its captain". Also the lower layers of MB corresponding to the lower levels of the hierarchy disappear. The decay of the organism continues down to the lowest molecular levels.

Note that the death can be seen as a cascade of BSFRs proceeding downwards to shorter scales and destroying quantum coherence since the metabolic energy feed keeping the distribution of the values of h_{eff} unaffected is not present or usable.

Geometrically the "loss of captain" means that the space-time sufrace does not continue outside the largest CD involved and having the largest h_{eff}. This is prevented by the classical conservation laws in the standard ontology but possible in ZEO. Also MBs associated with smaller CDs in the hierarchy can end at their boundaries.

Physically the loss means that dark photons radiated to the highest control level of MB as metabolic energy to keep the BE condensate, are not needed anymore and they leak out. The same happens at the lower levels as death proceeds to these levels. Interestingly, biophoton emission from dying plants increases and its intensity is used to deduce the age of vegetable.

7 Evidence for life after death in universal sense

In any BSFR the self identified as a sequence of SSFRs can be said to die and reincarnate with a reversed arrow of time and continue to live as a conscious entity with a reversed arrow of time. Selves would live forth-and-back in geometric time.

The experience about the previous life cycle would be represented as "silent wisdom" at passive boundary CD, as mental images which need not become conscious or are barely conscious.

7.1 General signatures of life with reversed arrow of time

The time reversal at the level of MB occurs in considerably longer time and spatial scales than for ordinary matter with $h_{eff} = h$ and is induced to the lower levels as an effective time reversal. This allows assigning of well-defined signatures to the presence of time reversed conscious entities. In the TGD Universe life and death are universal phenomena so that these signatures should appear in all scales. This makes it possible to test the theory if the general assumptions are accepted.

1. Time reversal implies that thermo-dynamical arrow of time for some layer of MB is non-standard. This can induce thermo-dynamical anomalies at the level of the ordinary matter. Already Fantappie [J24] proposed that time reversal is common in living matter and introduced the notion of syntropy as time reversed entropy. Dissipation with reversed arrow of time looks to the observer with standard arrow of time as a development of various kinds of gradients - gradients assignable to temperature, pressure, various chemical concentrations in biochemical systems, and to electric and magnetic fields. In particular cooling of the environment of a system, for which some layer of MB has suffered time reversal, is possible.

   Ordinary dissipation implies the decay of various structures, such as the decay of biomolecules to simpler building bricks. The time reversals of these processes can occur and the self-assembly of biomolecules challenging SL in standard form could at least in some cases involve time reversal.

2. At least in some cases SO could be induced by time reversed dissipation of the ordinary bio-matter induced by MB [L46]. There is evidence that living systems are quantum critical systems [I11]. In TGD entire Universe is quantum critical in the sense that the values of fundamental coupling constant Kähler coupling strength, are analogous to critical temperature.

   Self-organized criticality (SOC) is a phenomenon difficult to understand in standard physics context. Criticality is by definition unstable since the critical degrees of freedom act as repellors of dynamics. Even smallest perturbation can lead far away from the repelling point. If the arrow of the time is changed, the repeller becomes an attractor and the system tends to stay near criticality. This would give rise to self-organized quantum criticality (SOQC) [L79].

7.2 Examples about BSFR and death in various scales

In the following examples about BSFR as death of conscious entity in various scales are discussed.

7.2.1 Pollack effect and time reversal

The generalization of Pollack effect [I5, I1, I13, I9] plays a key role in TGD inspired biology.

1. As already explained, Pollack effect occurs in presence of energy feed such as IR photons, and means charge separation in water bounded by gel so that negatively charged exclusion zone (EZ) is formed.

2. EZ has the strange property that it drives out impurities: this is a thermodynamical anomaly. The interpretation is that the arrow of time is changed at MB controlling EZ and induces effective change of the arrow of time at EZ differing from the standard arrow of time of observer.

In TGD framework, Pollack effect generalizes also to other ions than H^+ - at least the positively charged ions inside neuronal (cell) membrane. Negatively charged entities are indeed abundant in biology.

1. DNA nucleotides involve negatively charged phosphate ion, which leads to the proposal that they are accompanied by magnetic flux tubes parallel to them carrying dark proton triplets as a representation of genetic codons [L15, L45, L58].

2. Cell interior is negatively charged, which suggests similar charge separation with positive charge assignable to dark ions at the magnetic flux tubes outside cell. Fermionic ions such as K^+, Na^+,.. could form Bose-Einstein (B-E) condensates of Cooper pairs whereas bosonic ions like such as Ca^{2+}, Mg^{2+}, Fe^{2+} could as such form B-E condensates. It is not clear whether also negatively charged ions like Cl^- form B-E condensates at flux tubes and whether they are in the interior or exterior of cell.

3. Microtubules carry constant negative charge density per unit length realized in terms of GTP molecules suggesting that they are accompanied by parallel flux tubes carrying say dark protons. Microtubules could be partially responsible for the negative charge of cell and could be related to the control of membrane potential.

7.2.2 BSFRs and homeostasis as self-organized quantum criticality

The article "*Homeostasis as self-organized quantum criticality*" [L79] was born as an attempt to understand the properties of cold shock and heat shock proteins (CSPs and HSPs). These proteins are similar and it is better to talk about stress proteins (SPs) having two different modes of operation.

Soon it became clear that the problem of understanding the behavior of SPs is only one particular facet of a more general problem: how self-organized criticality (SOC) or even quantum variant of SOC (SOQC) could be possible? Kauffman has indeed represented empirical evidence for quantum criticality at the level of biochemistry [I11]. As already explained, ZEO leads to a theory of SO and of SOQC.

In fact, living systems as a whole could be quantum critical and manage to stay near criticality, which means SOQC has interpretation as homeostasis. There would

be no life without death: homeostasis would be possible only by the temporary death/sleep/hibernation of subsystems. Homeostasis would not be due to extremely complex biological programs but caused by dissipation with a reversed arrow of time driving the system to quantum criticality.

7.2.3 Bio-rhythms as life-death cycles and living clocks

In TGD Universe, living matter is a population also in 4-D sense. Periodic processes of organism would correspond to sequences of CDs associated with sub-selves living forth-and-back in geometric time.

In the geometric future of a given CD decay process occurs and is followed by a generation of the self corresponding to the next CD in the sequence. The first half-period (lower half-cone of CD) would correspond to life and the second half-period (upper half-cone of CD) to a decay process. The next period would correspond to the next CD in the sequence defining a living and conscious biological clock.

EEG rhythms could be an example of this kind of life forms. There is indeed evidence that the first half of the EEG period is ordered and the second half is chaotic [J18]. Single EEG half period as a counterpart of a living system would represent mental images shifted towards the geometric future inside the CD after its birth.

Perhaps most periodic processes identifiable as bio-rhythms are such processes. The most obvious examples are breathing and heartbeat. At longer time scales the annual cycles represent similar examples.

7.2.4 ATPase as a rotating magnetic system (RMS)?

ATPase can be regarded as a molecular generator (acting in mode reverse to that of the motor) transforming metabolic energy to the energy needed by ADP$\rightarrow$ ATP transformation [I10]. The working mechanism of ATPase is not well-understood.

The behavior of rotating magnetic system (RMS) studied by Godin and Roschin [H1] suggests BSFR and time reversal at MB [**?**, **?**] which encourages the interpretation as a primitive life form [K1]. ATPase is analogous to the rotating shaft of a power plant and transforms metabolic energy to the energy of ATP molecule by transforming ADP to ATP. The rotation frequency of the shaft is around $f = 300$ Hz and corresponnds proton's cyclotron frequency in the endogenous magnetic field $B_{end} = 2B_E/5$ identified as the monopole flux part of B_E. ADP molecule transforming to ATP is the analog of the load. The energy would come from the metabolic energy feed.

Could MB of the ATPase be regarded as RMS perform time reversals periodically? The simplest option is that the periodic behavior of ATPase is analogous to breathing, which can be regarded as a sequence of CDs which make continual "Karma's cycle" with half-periods of cycle having opposite arrows of time. The in-breath with the negative arrow of time would extract metabolic energy to MB and breathing out would transfer it to ATPase and to the ADP$\rightarrow$ ATP transformation. MB would get its energy from metabolism from the flow of protons through the mitochondrial membrane transferred to dark protons at MB.

This mechanism might also apply to the RMS [H1] itself. The period is near 10 Hz and decompose to two half-periods with opposite arrows of time. This makes it

easier to understand how the energy is transferred to the load. RMS would breath with a frequency near alpha frequency.

7.3 Direct subjective evidence

NDEs provide subjective evidence for the continuation of conscious experience after death at the level of human conscious experience. The universality of death as BSFR suggests also other pieces of evidence of this kind.

7.3.1 Sleep,anesthesia, and hibernation as "small" deaths?

Sleep, anesthesia, and hibernation could involve BSFR at some layer of MB. Falling asleep would be a "small" death and waking up a "small" rebirth. No dramatic changes of world view usually occur during sleep. Can one conclude that the layer of MB and the corresponding CD are not changed dramatically in size so that the physical decay processes are avoided? The layer of MB could correspond to a considerably smaller size scale as in the case of biological death: this layer is not the "boss" at the highest level so that ship would still have the captain and the decay processes would not start.

7.3.2 After images as re-incarnations in the usual sense

The phenomenon of after images discussed from TGD point of view in [K14] suggests that mental images are born and die. The reincarnation of mental image as after image is analogous to "ordinary" reincarnation to be distinguished from the re-incarnation with a reversed arrow of time. The mental images would shift to the geometric future of "geometric now" and repeat their Karma's cycle suffering BSFR in memory recall.

The process generating after images would be analogous to the proposed process behind bio-rhythms. MB could have loops such that the signals circulating around loops serve as sensory input generating a sequence of after images.

8 Near-death experiences (NDEs)

The reason why I got interested in consciousness theorizing were two altered states of consciousness around (dating back to 1985 and 1988) sharing several features with NDE [L19]. These experiences destroyed my physicalistic belief system and induced dramatic changes in my personal life.

The Wikipedia article "Near-death experience" [J1] gives a good overall view about NDE, about research of NDE, and about theories of NDE.

Raymond Moody is the pioneer of NDE. He published his book "Life after Life" (1975) [J30] about the interviews of NEDrs. There are two accounts by medicine professionals about personal NDE that convinced them that neuroscience view about NDE is wrong. The book "To Heaven and Back: A Doctor's Extraordinary Account of Her Death, Heaven, Angels, and Life Again: a True Story" (2012) by Mary Neal [J26] and the book "Proof of Heaven: A Neurosurgeon's Journey into the Afterlife" (2012) by Eben Alexander [J12].

NDE can be studied scientifically. The article "The Science of Near-Death Experiences: Empirically investigating brushes with the afterlife" by Lichtfield [J21] summarizes the empirical reseach. Retrospective reseach relies on interviews of NDErs and its scientific soundness can be questioned: memories many years after NDE are not reliable and a documentation about the state of the NDEr during NDE is missing. Prospective studies can be made in hospitals so that a documentation about the state of the patient is available and the interviews can made immediately after NDE. It is even possible to test various claims such as autoscopy (seeing oneself from outside).

"The Handbook of Near-Death Experiences: Thirty Years of Investigation" (2009) [J22] edited by Janice Miner Holden, Bruce Greyson, and Debbie James (2009) summarizes the results of 30 years of scientific investigation since the book of Moody.

There is a book "Consciousness Beyond Life: The Science of the Near-Death Experience" (2010) by Pim van Lommel [J29] and the books "The Lazarus effect: the science that is rewriting the boundaries between life and death"(2013) [J36] and "What happens when we die: a groundbreaking study into the nature of life and death" [J35] (2018) by Sam Parnia. The book "A Doctor Explores What Near-Death Experiences Reveal about Life and Beyond" (2021) [J5] by Bruce Greyson has been published quite recently.

8.1 What NDEs are?

The challenge is to understand the structure of NDE and its often deep effect on the life of NDEr.

8.1.1 NDE experience

The following aspects of NDE experiences summarized in Wikipedia article [J1] seem to be rather universal. These basic elements need not be in the order of the list below.

- Out-of-body experience (OBE) as sensing detachment from body and seeing own body from outside and awareness of being dead.
- Sensation of darkness, tunnel experience, and movement toward/or sudden immersion in a powerful light; unconditional love and acceptance; encountering beings of light; reuniting with deceased loved ones.
- Life review.
- Decision by onself or others to return back and reluctance to return.
- Suddenly finding oneself in one's own body.

Kenneth Ring (1980) [J23] subdivided NDE on a five-stage continuum:

- feeling of peace;
- body separation and OBE;

- entering darkness and tunnel experience;
- seeing the light and meeting light beings and already dead beloved ones;
- return to own body.

The above picture is over-simplified.

1. NDE does not have always a positive emotional coloring. About 25 per cent of NDEs involve negative emotions such sensations of anguish and distress.
2. Universality is not complete: the notions used to describe NDE depend culture, in particular religious background.
3. Charlotte Martial, a neuropsychologist who led a team that investigated 154 NDE cases, concluded that findings challenge the assumption about a fixed sequence of events [J19] (see `https://cutt.ly/ZkPdiBT`).

   However, NDE seems to always begin with OBE and end with a return to own body. The most common order of events was OBE; being aware of a tunnel; seeing a bright light; and finally a feeling of peace. This exact sequence was reported in 22 percent of the 27 experiences that had all these 4 basic elements.

   Whether the order of basic elements of NDE is not fixed or not, matters if the goal is to build a concrete model for NDE. Neuroscience can provide possible identifications for the components of NDE that would occur in "disturbed bodily multisensory integration" but holistic view is lacking.

8.1.2 After effects of NDE

NDE has often profound after effects. Physiological effects include heightened sensitivity to light at some frequencies, sound, and certain chemicals. NDErs can also have a strange influence on electrical equipment.

There are effects in behavior and attitudes towards other people. The documented changes include "a greater appreciation for life, higher self-esteem, greater compassion for others, less concern for acquiring material wealth, a heightened sense of purpose and self-understanding, desire to learn, elevated spirituality, greater ecological sensitivity and planetary concern, and a feeling of being more intuitive".

The new value system can lead to trouble in everyday life. The feeling of unconditional love towards everyone can be problematic for both NDEr and her relatives and friends. NDEr can leave a well-paid job and devote time to something which she experiences as a mission of life. NDE can induce radical changes in relationships.

8.1.3 Physiological correlates of NDE

The following is a list about the basic physiological correlates of NDE.

1. EEG is absent during the experience. There is no pulse and breathing has stopped. Oxygen based metabolism is reduced leading to hypoxia or even anoxia. It is highly questionable whether the neural activity can receive the needed energy from oxygen based metabolism.

2. The experiments with rats suggest that NDE follows an intense gamma peak in the EEG (around 40 Hz) after 30 seconds of death. Meditative states begin with gamma peak followed by alpha peak. The states involving NDE can last for hours. It is difficult to understand how clinically dead brain could give rise to NDEs at all. It is not clear how long NDEs can be.

3. Pupils are fixated and dilated so that visual experiences seem impossible. How visual percepts could be produced? It has been proposed that biophotons could produce the visual perceptions during NDE [J8] in the visual cortex. The intensity of biophotons might indeed increase in biological death (decaying vegetables emit biophotons [I7]). The visual sensations of this kind are however simple dots or light, phosphenes: how could they integrate to visual perceptions?

4. Meditators can produce NDEs at will and can even control them. Also psychedels, in particular DMT produced by body, and present in mammalian pineal gland [J31] can predictably produce NDE-like experiences. The concentration of DMT in the hippocampus of rats having heart arrest increases.

   What the function of DMT (`https://cutt.ly/Izq2mEz`) and pineal gland serve could be in the creation of third person perspective and various aspects of NDEs and altered states of consciousness in general?

8.2 Explanations of NDE

The explanations of NDE [J1] can be classified as trancendental/religious, psychological, and physiological.

Many transcendental and religious beliefs about after-life include descriptions similar to NDEs. According to the dualistic interpretations of NDE soul lives in the body and temporarily leaves it in NDE.

Both dualistic, materialistic, and idealistic theories of consciousness have serious problems. If one requires that dualistic theory is consistent with empirical science, it it is difficult to avoid a reduction to materialism having its own problems about which the problems of idealistic theories are mirror images [J11]. Susan Blackmore [J33, J34, J32] is an advocate of physiological explanations and sees consciousness as an illusion. One can of course wonder what the identification of consciousness as one particular phenomenon of consciousness does really mean.

According to the neuroscientific hypothesis NDE is a subjective phenomenon due to "disturbed bodily multisensory integration" that occurs during life-threatening events. The experience would not reflect reality but the disturbed state of the brain. What does "disturbed bodily multisensory integration" mean and how it is produced, remains unclear.

There are several objections against the neuroscientific hypothesis.

1. Advanced meditators can generate NDE at will; NDE is universal- even children can have NDEs; NDE is well-organized rather than a bundle of chaotic sensations; the empirical justification of the hypothesis is missing.

2. How a clinically dead brain could produce such complex and structured perceptions and even simulate sensory third person perspective at the level of sensory experience? We do not even understand how a living brain can produce ordinary perceptions in the first person perspective.

Concerning the explanation of NDES there several philosophical guidelines.

1. Cognitive third person perspective is part of conscious experience, which is not easy to understand. Sensory third person perspective is even more difficult to understand from the neuroscience perspective. It is difficult to identify a physical correlate for the "third person" in physicalistic approach.

2. Many eastern philosophies based on introspective study of conscious experience emphasize that the identification of the experiencer with the physical body is an illusion. Is even the notion of experiencer only a convenient auxiliary notion? Are only experiences fundamental? This need not mean accepting idealism.

It is hard to see how NDEs could be understood without having a theory for conscious experience. The theories of consciousness based on materialism, idealism or dualism meet profound problems, and something new seems to be needed.

8.3 Psychological and physiological explanations of NDE

The summary of psychological and physiological explanations of NDE follows the Wikipedia article [J1].

8.3.1 Psychological explanations

Depersonalization model, expectation model, dissociation model, and birth model represent the basic psychological explanations.

1. Depersonalization model

According to the model, "persons who face their impending death become detached from the surroundings and their own bodies, and no longer feel emotions, and experience time distortions"".

Wikipedia article mentions following objections against the model. The model does not explain NDEs for subjects who do not experience OBE; unlike NDEs, the depersonalization experiences are dreamlike, unpleasant and characterized by "anxiety, panic and emptiness". Also, during NDEs subjects remain very lucid of their identities, and their sense of identity is not changed.

2. Expectancy model

Expectancy model states that although NDE appears very real, it is actually been constructed in the mind in response to the stress of an encounter with death, and does not correspond to a real event.

Wikipedia mentions following objections. Subjects' accounts often differ from their own religious and personal expectations regarding death whereas imagined

scenario would rely on their cultural and personal background. The NDEs of meditators do not conform with this proposal.

3. Dissociation model

Dissociation model proposes that NDE is a form of withdrawal to protect an individual from a stressful event. Under extreme circumstances, some people may detach from certain unwanted feelings in order to avoid suffering associated with them. Detachment from one's immediate surroundings occurs.

The model explains the OBE aspect of NDE but does not say much about other aspects.

4. Birth model

The birth model suggests that near-death experiences could be reliving the trauma of birth. Since a baby travels from the darkness of the womb to light and is greeted by the love and warmth of the nursing and medical staff, and so, it was proposed, the dying brain could be recreating the passage through a tunnel to light, warmth and affection.

The basic objection is that newborns do not possess "the visual acuity, spatial stability of their visual images, mental alertness, and cortical coding capacity to register memories of the birth experience".

8.3.2 Physiological explanations

A wide range of physiological explanations of NDE have been proposed and can be classified according to whether the disturbance is neuroanatomical (say abnormal activity in the temporal lobes), due to the imbalance involved molecules neural blood gas models (cerebral hypoxia, anoxia, and hypercapnia) or due to the imbalance associated information molecules (endorphins and other neurotransmitters). Also multifactorial models for NDE including endorphins, neurotransmitters of the limbic system, the temporal lobe and other parts of the brain have been proposed.

1. Neuroanatomical models

Olaf Blanke and Sebastian Dieguez [J7] suggest a neuroanatomical model assigning NDES with a malfunction of temporal-parietal junction:

1. "Type 1 NDEs are due to bilateral frontal and occipital, but predominantly right hemispheric brain damage affecting the right temporal-parietal junction and characterized by OBEs, altered sense of time, lightness vection (sensation of bodily motion) and flying.".

   Remark: When younger, I had this kind of experiences. In particular, I experienced a perfect translational motion: as I was leaving the room my children returned me back. There was also a sensation of perfect spinning motion. As if I had been an elementary particle-like entity. This brings in mind M^8 mode suggested by $M^8 - H$ duality replacing space-time with momentum space.

2. "Type 2 NDEs are due to bilateral frontal and occipital, but predominantly left hemispheric brain damage affecting the left temporal parietal junction

and characterized by feeling of a presence, meeting and communication with spirits, seeing of glowing bodies, as well as voices, sounds, and music without vection.".

According to French [J9] "temporal lobe is almost certainly involved in NDEs, given that both damage to and direct cortical stimulation of this area are known to produce a number of experiences corresponding to those of NDE, including OBEs, hallucinations, and memory flashbacks".

According to Greyson [J4] "multiple neuroanatomical models have been proposed in which NDEs have been hypothesized to originate from different anatomical areas of the brain, namely: the limbic system, the hippocampus, the left temporal lobe, Reissen's fiber in the central canal of the spinal cord, the prefrontal cortex, the right temporal lobe. Although some of the neuroanatomical models proposed may help to explain NDEs, they remain speculative at this stage since they have not been tested in empirical studies.".

2. Neurochemical models

Imbalances of various neurotransmitters (such as glutamate, noradrenaline, dopamine, endogenous opioids, serotonin). There are indeed similarities between NDEs and effects of hallucinogens.

According to Parnia [**?**], neurochemical models are not based on actual data. Parnia writes that no data has been collected via thorough and careful experimentation to back "a possible causal relationship or even an association" between neurochemical agents and NDE experiences.

3. Altered blood gas levels models

Low oxygen levels characterize life-threatening situations. Anoxia or hypercarbia (abnormally high level of CO_2 in blood) are hypothetized to produce phenomena such as seeing brilliant lights, reliving past memories and OBE.

The visual cortex dysinhibition that accompanies anoxia (severe hypoxia) has been suggested as an interpretation of tunnel-like perception during NDEs.

Hypoxia as a cause of NDE could be justified by the similarities between NDEs and G-force induced loss of consciousness (G-LOC) episodes that result in lack of sufficient blood supply to the brain probably causing cause hypoxia. The G-LOC experiences often involve several characteristics of NDEs [J1].

Hypoxic hallucinations are however characterized by "distress and agitation" unlike NDEs. Hypoxia-induced acceleration's primary characteristics are "rythmic jerking of the limbs, compromised memory of events just prior to the onset of unconsciousness, tingling of extremities ..." which are not observed during NDEs. Life reviews, mystical experiences and long-lasting after-effects are also missing.

8.4 TGD based view about death

In this section a possible TGD based view about what might occur in biological death is developed. The model is of course only one particular story, and can be defended only by the facts that it is based on a general vision about consciousness, biology and neuroscience, is internally consistent, and does not have any obvious conflicts with empirical facts.

8.4.1 Biological death as process

The first challenge is to build a mmodel for biological death.

1. Breathing and heartbeat cease which leads to a loss of oxygen based metabolism. EEG disappears too after gamma peak (at least in the case of rats). Pupils are fixated and dilated.

2. Sleep as a "small death" is in many respects similar to death and could represent an example of a life cycle in an opposite time direction. Falling asleep involves a shift of EEG frequency scale below the alpha band around 10 Hz. There are four stages of sleep and the lowest frequency scale is around 3 Hz. Since EEG wavelengths naturally correspond to the size scales of MBs, the size scale of MBs receiving sensory input would increase in the process. Gradually the sizes of MBs receiving information from BB would increase. At least four size scales for MBs corresponding to EEG bands during sleep would be involved [K11, K3, K10, L72].

   This is expected to happen also in biological death and the disappearance of EEG could mean that EEG shifts to so low frequencies that it effectively disappears.

3. This suggests that the death proceeds from short to long scales in the hierarchy of MBs and CDs as the feed of metabolic energy from lower to higher levels ceases and the values of h_{eff} are reduced. Since the size scale L of CD is expected to be $L = (h_{eff}/h)L(h)$, also its size is reduced if $L(h)$ is not changed. This would allow the reincarnated self to experience "childhood".

   $h_{eff} = h$ need not be reduced if $L(h)$ is reduced. One however expects that ontogenesis involves the emergence of levels with increasing value of h_{eff} in the hierarchy of MBs/CDs.

4. Eventually NMP forces BSFR for CDs/MBs if the negentropy gain is larger for BSFR than for SSFR. In BSFR the arrow of time changes and the energy of the 3-D state initiating time reversed evolution increases. The idea that this could occur is also suggested by the BSFR based model [L78] for the rotating magnetic system (RMS) studied by Godin and Roschin [H1] starting to accelerate spontaneously.

   Sub-CDs wake up by BSFR to live in the standard time direction and their h_{eff} increases and the system wakes up. For the geometric time larger than the moment of geometric time associated with BSFR this looks like a revival. Breathing, heartbeat, metabolism, EEG and other basic rhythms are re-established and the person finds himself in her own body.

5. BSFR at a given level of hierarchy need not be able to generate enough metabolic energy by time reversed dissipation to induce a revival. In this case the next level in the hierarchy of CDs can try this. If all these attempts fail death happens.

8.4.2 What could the peak in EEG gamma band mean?

The dying process begins with a peak of EEG activity (at least in the case of rats) in the scale of the entire brain lasting about half a minute.

Consider first a summary of the findings concerning the EEG of rats suffering heart arrest as given by Bokkon et al [J8], who proposed a model for the visual sensations of NDE in terms of bio-photons.

Borjigin et al. (2013) [J14] recorded EEG signals over the frontal, parietal, and occipital cortices bilaterally in rats during wakefulness, anesthesia, and cardiac arrest. Within the 30 s after the rats' hearts stopped beating it was revealed that cardiac arrest produced a transient and global surge of synchronized gamma oscillations of brain activity that exceeded the waking state.

Also high levels of global alpha-gamma coupling was found. This suggests that the visual cortex can be highly activated in cardiac arrest. Previous studies indicate that alpha-gamma coupling is especially important for visual perception [J20]. In particular increased gamma intensity in an area of the brain that is right on top of the visual cortex is detected. The speculation was that the activation level is high and gives rise to visual aspects of NDE.

Could gamma peak occur for humans? The proposal of Bokkon et al [J8] is that gamma peak is accompanied by biophotons assumed to be created by radicals related to oxygen based metabolism and these give rise to NDE. There is evidence that light induces phosphene like sensations in the brain. It is however difficult to understand how this could lead to a highly organized sensory perception. Also the assumption that biophotons originate from molecular transitions is questionable since there is no discrete spectrum charactering molecular transitions.

What could be the interpretation of the gamma peak in TGD framework?

1. The brain must receive metabolic energy from some source. In stress situations like cold shock MBs of stress proteins (SPs) would provide the metabolic energy [L79] by extracting it from the environment during the time reversals induced by BSFRs. For instance, heating of DNA and proteins becomes possible in cold shock. An essential aspect of survival under stressful situations would be a hibernation like state at cellular level induced by BSFR. SPs could play important role also in NDE.

   The admittedly speculative model for the rotating magnetic system (RMS) of Godin and Roschin [H1] [L78] exhibiting the signatures of BSFR suggests guidelines. The observed spontaneous acceleration would receive the needed energy from MB of RMS as it experiences BSFR. BSFR would not break conservation of energy but only reshare the energy between RMS and its MB. Even the higher layers MB could provide metabolic energy in this manner in stress situations.

2. Could MB itself make BSFR - die - to resuscitate the lower level? This inevitably brings in mind the story about Jesus who died to save the mankind! There are also variants of story telling that Jesus lived another life before resurrection: time reversed life? Maybe myths try to tell us something which our present day science is unable to express.

Could the death process involve a resuscitation trial by MB? First the lowest layer of MB makes BSFR and if it succeeds, revival occurs. If not, the layer above it tries and so on. The death of a given layer as BSFR induces time reversed dissipation and effectively allows the lower level of hierarchy to extract energy from environment and use as metabolic energy and wake up the lower levels by providing metabolic energy to these. If some level manages to make it, resuscitation happens. If not, death occurs. This picture leads to ask whether the EEG peak could be followed by several secondary peaks.

What would be the exact function of the EEG peak in gamma band?

1. The EEG peak could mean communications between BB and MB and control by MB. Gamma peak correlates with vision and gamma activity couples to alpha activity: gamma peak and its coupling to alpha is known to occur in the transition to meditative state and NDE has basic aspects of meditative state.

   Could the gamma peak correspond to dark photons with energies of visible light? How could gamma peak relate to the first stage of NDE involving tunnel experience and darkness, which is also a visual experience rather than lack of visual consciousness and proposed to relate the anoxia causing narrowing of the visual field?

   How could gamma peak relate to the experience of seeing the light and light beings difficult to understand as a consequence of hypoxia or anoxia? Where does not light come from and where it is received? Does the light arrive from personal MB? Retinas cannot serve as receptors since during NDE if they are not functional. Hence the proposal that NDE could correspond to virtual sensory input from MB to eyes is not plausible.

   Could MB utilize pineal gland - the "third eye" - as a sensory receptor to which dark light would be transferred from MB via visual cortex. This picture conforms with the view about dreams, psychedelic experiences, hallucinations, and imaginations. This might also allow understanding of auditory experience if dark photons are the mediators of also auditory information perhaps transferred to ears.

8.4.3 Pineal gland as "third eye" in NDE?

Pineal gland [J17] - called by Descartes principal seat of soul - is also known as "third eye" and indeed resembles eye in that it has pigments appearing in the retina. For some animals the counterpart of pineal gland still serves in the role of eye. Pineal gland is unique in that it does not decompose to right and left parts and might therefore act as a central sensory unit.

The presence of DMT in the pineal glands of mammalian brain is documented [J16] (`https://cutt.ly/8k5eQSS`). According to the researchers, the discovery of the pineal gland as a source of DMT reinforces the idea of the role of this enigmatic gland in unusual states of consciousness. DMT has been linked to the generation of images in dreams, with the states of consciousness that generate NDEs and various mystical experiences. In rats suffering heart arrest the concentration of DMT in pineal gland increases.

Rick Strassman has studied the effects of DMT on volunteers [J31]. DMT consistently produced NDEs and mystical experiences. Many reported convincing encounters with intelligent nonhuman presences, aliens, angels, and spirits. Nearly all felt that the sessions were among the most profound experiences of their lives.

The curious finding is that the pineal gland becomes visible in the human fetus at 49 days, which is the number of days in which a soul takes to reincarnate according to the Bardo Thodol (Tibetan Book of the Dead). These coincidences have led Strassman to affirm that the soul incarnates in the body at the seventh week of pregnancy.

Could this establish a connection to MB? Could the third person aspect of consciousness emerge before the first person aspect? Interestingly, small children can talk about themselves in the third person perspective.

These findings motivate the question whether pineal gland could act as a third eye and maybe also third ear during NDE?

1. In the TGD based model for brain, neural transmitters and various information molecules serve as relays inducing flux tube connections. The binding to receptors would connect the magnetic flux tubes assignable to pre- and post-synaptic neurons to longer flux tubes, which act as wave guides for dark photons and mediate sensory information from sensory organs to brain and from brain to MB.

   The EEG frequencies associated with these flux tubes are inversely proportional their length and EEG wavelengths could correspond to the flux tube lengths. Could the EEG burst build flux tube connections also for frequencies below EEG range.

2. Various information molecules, in particular DMT which acts as psychedelic and is produced by the brain itself, could connect the flux tubes at neuron level to long flux tubes building connections to the distant layers of MB.

3. Could DMT serve as a relay to build the flux tube connections to higher layers of MB and communicate its third person sensory input to pineal gland as dark photons? Gamma peak suggests that DMT as relay builds flux tube connections to visual cortex already having these connections to MB.

   In TGD framework sensory organs are carriers of sensory qualia and sensory perception requires feedback from MB and brain as a virtual sensory input as dark photons to sensory organs to build standardized mental images [L33]. In the case of NDEs virtual sensory input to eyes and ears is absent also in TGD unless REMS intrusions and their auditory analogs occur. A feedback loop between MB and pineal gland could in principle could make possible building of organized sensory percepts and pattern completion.

   If the pineal gland serves as a kind of organizing center, not only visual but also auditory input during the entire NDE including OBE, tunnel experience and darkness would be amplified using pineal gland as a sensory organ. Gamma peak would not give rise to NDE but make NDE possible. It would be analogous to the gamma peak coupled to alpha peak that precedes the transition

to a meditative state. Meditators can indeed produce artificially NDE like experiences so that the same mechanism would work also in this case.

4. The reports of Terence McKenna about psychedelic experiences starting with a detachement from body also conform with many aspects of NDE. Also psychedelics could act as relays inducing this kind of connections and psychedelic experience and NDE indeed have some common features. This leads to ask whether the experiences induced by psychedelics and involving meeting of members of advanced civilizations could be real in the sense that remote sensory experience is involved [L8, L16, L17]. Note that if these experiences are based on sending light signals reflecting back with an opposite arrow of time (BSFR for the flux tube carrying the signal), finite light velocity is not a problem.

8.4.4 Could pineal gland also act as a third ear?

There are indications that pineal gland could also act as a third ear.

1. The article of Baconnier et [J13]) tells about a discovery of calcite microcrystals in the pineal gland of the human brain. These studies were carried out using electron diffraction and Raman spectroscopy to view cubic and hexagonal morphologies. The only other known deposits of crystal in the human body occur in the otoconia structure of the inner ear. The suggestion is that this rare crystallographic symmetry has links to the piezo-electricity, and investigations continue to understand the bio-electromagnetic crystalline connection between the pineal gland and inner ear.

   Calcites are present also in ear. This suggests that they transform the incoming sound signal to dark photon signals propagating into brain and MB and also receive the virtual auditory input as dark photons transformed to acoustic oscillations. Oto-acoustic sounds are sometimes heard even by an outsider.

   In [L33] it is proposed that pineal gland could serve as a relay station at which the dark photon radiation from MB could generate imagined visual and hearing sensations as almost sensory experiences or send the signal to the sensory organs. NDEs suggest that the sensations could be created already in pineal gland so that in some circumstances it could also act as a third ear. At ears the calcite crystals would transform sound to dark Josephson radiation transferred to MB, where they would generate a sequence of resonance peaks communicated back to the brain and inducing a nerve pulse sequence as a cognitive representation of the sensory input.

2. The action of pineal gland as a third ear could explain several strange subjective experiences that I have had during years. For instance, when I wake-up partially so that my body continues to sleep, I hear my own snoring as an outsider and it takes time to realize that it is actually me. The intensity of the sensation is considerably stronger than usually. Does my personal MB directly listen to my breathing and perhaps also sounds from the environment

- at least those created signalling the presence of living entities - and communicate the sensory data to my pineal gland and wake-up me if needed? MB would act as a "guardian angel"".

3. Crystals are not present only in the brain. Bones - and also pineal gland - contain hydroxyapatite, a mineral form of calcium apatite $Ca_{10}(PO_4)_6(OH)_2$. Hydroxyapatite contains Posner molecules $Ca_9(PO_4)_6$ proposed to play crucial role in quantum biology by Mathew Fisher [J27] (see `http://tinyurl.com/hd3t6sr`): Posner molecules are discussed from the TGD point view in [L13] and it is proposed that the 6 phosphorus atoms in could define the 6 bits of genetic codon playing a fundamental role in the dark photon communications using the GC realized as bio-harmony [L9, L10, L58, L73].

   Could also bones act as senders and receivers of sound and dark photon signals to MB and back and make the third person aspect of sensory consciousness possible and perhaps present during the sleep? Note that shivers in spine - possibly related to quantum coherence - are induced by experiences with a strong negative or positive emotional color, in particular good music.

4. This picture could also explain the basic aspects of my own "great experience" [L19]. It started with an amplification of sounds and shiver in the spine and spread into my entire body. There was a very concrete experience about contact with an entity that I called "Great Mind". Soon I realized that in some sense this "Great Mind" was actually me. Years later I realized that this experience is analogous to experiencing of Brahman=Atman identity: MB was the Brahman. I also saw a complex forth-and-back flow of dots associated with throats. I have interpreted the flow as a magnetic flux associated with flux tubes connecting me to MB: magnetic flux is indeed mathematically analogous to incompressible liquid flow.

8.5 TGD based model for NDE

The existing data give really strong tests and allow to develop more detailed picture about what might happen in death and NDE.

8.5.1 What happens in OBE

Consider first a sketch for what might happen in OBE.

1. The experience starts with OBE. The roles of the environment and observer effectively change: the perceiver becomes the perceived one. The third person aspect of experience is actually present always but not at the level of sensory input.

   The following analogy might help. Consider a video stream about room at TV screen watched by a person. The disappearance of the video stream from the screen serves as an analog for OBE. The video stream having the screen as blind spot would be analogous to the ordinary sensory input, and the direct

visual perception of room including TV screen would correspond to the third person sensory input.

2. EEG is flat and does not communicate sensory data about the environment via BB to MB. MB as the "third person" must receive sensory information about BB as seen from outside. The sensory information could be communicated as dark photons emitted by dying BB produced as Josephson radiation from cell membranes and as dark cyclotron BE condensates decay in the absence of metabolic energy feed. Dying plants indeed emit biophotons as a small fraction of dark photons transforms to ordinary photons [I4, I2].

   Eventually enters the darkness: this does not however mean absence of visual consciousness. The interpretation is that the burst of dark photons resulting from the reduction of the values of h_{eff} is over and MB cannot anymore see BB unless secondary burst occur.

   Rotating magnetic systems (RMSs) [H1] [L78] exhibiting BSFR provide another analogy: during spontaneous acceleration there is ionization of the air caused by the liberated visible and UV radiation as analog of biophoton emission.

3. An interesting challenge for the model are NDEs involving true memories about the conversations of the hospital personnel performing resuscitation. Could the sound waves in the environment generate the signal sent to MB directly?

   Could the oscillations of flux tubes of MB analogous to Alfwen waves and those of vibrating string provide fundamental representation of sound and the correlates for the auditory qualia: this would mean that auditory qualia are realized at the fundamental level as some easterm philosophies propose.

   The proposal that GC is realized for dark photons [L58, L73] inspires the question whether also dark phonons realize GC and whether the music experience could rely on dark phonons and dark phonon triplets as basic chords coding for the harmony?

   Could pineal gland serve as an ear? Could it serve as a central unit to which sensory inputs from both right and left hemi-sphere converge?

8.5.2 Tunnel experience, immersion into light

A physiological explanation of tunnel experience is reduced visual perception due to the metabolic restrictions caused by hypoxia or even anoxia. This model generalizes to the TGD framework.

1. In TGD framework the sudden emergence of light might be interpreted as the start of visual input from MB as sensory input to pineal gland.

2. This does not explain the movement along the tunnel. What moves and where does it move? The reconnection of U-shaped flux tubes for two systems creating a pair of flux tubes connecting the systems is a necessary prerequisite for dark photon communications by resonance. Could the motion of the U-shaped

flux tube (kind of tentacle) emerging from the brain and eventually meeting the U-shaped flux tube from MB create the sensation of motion along a tunnel and the emergence of light? This would initiate the sensory input from MB.

One can also ask whether, tunnel experience and immersion into light could be understood as sensory memories about birth as the psychological explanation of NDE proposes? Sensory memories indeed accompany NDEs.

1. The basic objection is that the memories about this period are not linguistic: the immersion to light instead of having detailed visual view would conform with this since the infant does not cognize and cannot decompose the visual input into objects (if congenitally blind people get vision back, they see only diffuse light).

2. Note however that if the child entangles with her mother negentropically, she could share the mother's sensory mental images to perceive and perhaps even interpret the world. The experience of unconditioned love and peace during this period of NDE could correspond to a memory about maximal entanglement with mother before the moment of birth. NEDrs report also meeting of light beings relatives, friends, and beloved ones. Do they correspond to a later part of life review or does the negentropic entanglement with mother make this kind of experience possible also immediately after birth?

3. Memories would be represented essentially sensory mental images - conscious entities living in the geometric future of the deceased self and inside its CD, which is inside the larger CD of MB. Memory mental images should radiate positive energy dark photons located in their geometric future to MB and form a representation of the memories much like in the case of sensory memories. It is difficult to build a more detailed model. Clearly, this model involves more assumptions than the first model.

8.5.3 Life review and the decision to return

Life review is an abstraction and a summary about lived life is in question. Could the emergence of this reflective level be due to the increase of h_{eff}?

The idea about how MB gives rise to abstractions was inspired by the TGD inspired model [L84] of findings of Armor and Sackett [J3] suggesting that the outcome of an event is more predictable if it is known to occur. A concrete model for MBs could give rise to abstractions at the level of MB relying on hyperbolic geometry of proper time constant hyperboloid of M^4 is discussed in [L60].

Where could the information for life review come from? MB in the future of CD of time reversed layer of MB is the experiencer. The memory mental images of previous life which correspond to sub-CD:s of this CD and are in the geometric past are somehow responsible.

Why they would send positive energy photons to future? Could they do this because they experience BSFR. Analogy with biophotons sent by an organism after death as the metabolic energy is liberated. The radiation would represent the mental images.

What making the decision about return could mean? The return would mean second BSFR re-establishing the original arrow of time and leading to a revival. NMP forces BSFR [L76] so that the decision maker would be an abstract principle rather than any conscious entity.

8.6 After effects of NDE

The psychological after effects of NDEs could be understood in terms of the two BSFRs which can profoundly affect the "silent wisdom" associated with passive boundary of CD. Also the actual memories located in the half-cone representing active half of CD are changed.

NDErs are sensitive to light at some wavelengths and their presence has strange effects on electronics.

1. The sensitivity to light at some wavelengths should relate to dark photons having energy spectrum in visible and UV. Flux tubes of MB have cyclotron frequencies (very low) but due to the large value of $h_{eff} = h_{gr}$ the energies are in the biophoton range. The natural guess is that the connections to some part of MB with cyclotron frequencies which correspond to certain wavelengths is strengthened in NDE.

2. The emission of this light changing partially to ordinary photons (biophotons) might also cause the effects on electronics. Electronvolt is the natural energy scale of energies for charged particles accelerating along flux tubes in electronic systems, where Volt is the typical scale of voltage. Therefore these dark photons could have effects on MB of electronic systems. $1/f$ noise in electronic systems is poorly understand: could it be assigned to MB as an analog for biophotons resulting from dark photons. If this were the case the distribution of flux tube lengths would be scale invariant and go like 1/length: this is in accordance with fractality.

9 Conclusions

Let us summarize the basic vision about life after death proposed in the essay.

1. TGD inspired theory of consciousness relies on adelic physics, which fuses the physics sensory experience based on reals with physics of cognition relying on p-adic number fields. Entanglement negentropy is always non-positive in ordinary physics but in adelic physics it also contains a cognitive contribution and can be positive for EQs.

   NMP is the basic variational principle of consciousness and generalizes SL and implies it for ordinary matter. The net increase of negentropy is by NMP however non-vanishing.

2. According to ZEO based quantum measurement theory, consciousness, life and death are universal phenomena. This can be tested in all length scales varying from nuclear physics scales to astrophysical scales by trying to identify

signatures of time reversal. For an observer with a standard arrow time dissipation with a reversed arrow of time manifests as thermo-dynamical anomalies. Generation of gradients and structures and SO and also SOQC giving rise to homeostasis in biological systems are the basic signatures.

3. The biological applications include models of quantum biology and quantum brain relying on the notion of MB and $h_{eff} = n \times h_0$ hierarchy predicted by adelic physics.

   The basic prediction is quantum coherence of layers of MB in arbitrary long length scales. Since MB is in the role of master in the master-slave hierarchy, it induces the coherence of ordinary biomatter at the bottom of the hierarchy.

   This vision leads to a model of aging and biological death. Aging would be basically due to the approach of MB and BB to a thermal equilibrium as the temperature of MB increases and approaches to Hagedorn temperature [B1] of flux tubes near the physiological temperature. By its large heat capacity MB could also be an ideal metabolic energy storage and MBs of at least stress proteins would have this function.

4. The quantum model of the brain differs from standard neuroscience view in several respects. MB controls BB and brain and uses them as sensory receptors and motor organs in a general sense. Quantum coherence allows the identification of sensory organs as seats of fundamental qualia although also basal ganglia inside the brain could play this role. In particular, pineal gland could serve as a sensory organ during NDEs.

5. A model for what happens in biological death is developed using NDEs as input. One can say that MB performs a hierarchical resuscitation operation: BSFR at a given level n of this hierarchy induces BSFR. This however provides metabolic energy to the level $n-1$ possibly inducing a revival so that the temporary death at level n gives hope about rebirth as second BSFR at level n. If not, the level $n+1$ tries the same. The analogy with the key story of Christianity is obvious. Also a model for NDE is developed explaining its basic aspects such as OBE experience, tunnel experiences and immersion into light, meeting of light beings dead beloved ones, life review, and decision to return. OBE would correspond to third person sensory perception with MB in the role of perceiver. The sensory input could be sent by MB to the brain and amplified at the pineal gland taking the role of eyes and ears as a central sensory receptor.

10 Appendix A: Brief glossary of the basic concepts of TGD

The following glossary explains some basic concepts of TGD and TGD inspired biology.

- ***Space-time as surface***. Space-times can be regarded as 4-D surfaces in 8-D space $M^4 \times CP_2$ obtained from empty Minkowski space M^4 by adding

four small dimensions. The study of field equations characterizing space-time surfaces as "orbits" of 3-surfaces (3-D generalization of strings) forces the conclusion that the topology of space-time is non-trivial in all length scales.

- ***Geometrization of classical fields***. Both weak, electromagnetic, gluonic, and gravitational fields are known once the space-time surface in H as a solution of field equations is known.

  Many-sheeted space-time (see **Fig. ??**) consists of space-time sheets with various length scales with smaller sheetd being glued to the larger ones by ***wormhole contacts*** (see **Fig. ??**) identified as building bricks of elementary particles. The sizes of wormhole contacts vary but are at least about CP_2 size (about 10^4 Planck lengths) and thus extremely small.

  Many-sheeted space-time replaces reductionism with ***fractality*** . The existence of scaled variants of physics of strong and weak interactions in various length scales, and biology is especially interesting in this respect.

- ***Topological field quantization (TFQ)*** . TFQ replaces classical fields with space-time quanta. For instance, magnetic field decomposes into space-time surfaces of finite size representing flux tubes or sheets. Field configurations are like Bohr orbits carrying "archetypal" field patterns. Radiation fields correspond to topological light rays or massless extremals (MEs), magnetic fields to magnetic flux quanta (flux tubes and sheets) having as primordial representatives "cosmic strings", electric fields correspond to electric flux quanta (say cell membrane), and fundamental particles to CP_2 type vacuum extremals.

- ***Field body*** (FB) and ***magnetic body*** (MB). Any physical system has field identity - FB or MB - in the sense that a given topological field quantum corresponds to a particular source (or several of them - say in the case of the flux tube connecting two systems).

  In Maxwell's electrodynamics one cannot achieve this kind of identification since the fields created by different sources superpose. Superposition is replaced with a set theoretic union: only the *effects* of the fields assignable to different sources on test particle superpose. This allows to define the quantum field theory limit of TGD.

- ***p-Adic physics*** [K16] as a physics of cognition and intention and the fusion of p-adic physics with real number based physics are new elements.

- ***Adelic physics*** [L23, L25] is a fusion of real physics of sensory experience and various p-adic physics of cognition.

- ***p-Adic length scale hypothesis*** states that preferred p-adic length scales correspond to primes p near powers of two: $p \simeq 2^k$, k positive integer.

- ***Dark matter hierarchy*** realized in terms of a hierarchy of values of effective Planck constant $h_{eff} = nh_0$ as integers using $h_0 = h/6$ as a unit. Large value of h_{eff} makes possible macroscopic quantum coherence crucial in living matter.

- ***MB as an intentional agent using biological body (BB) as a sensory receptor and motor instrument*** . Personal MB has a hierarchical onion-like layered structure and several MBs can use the same BB making possible remote mental interactions such as hypnosis [L5].

- ***Magnetic flux tubes and sheets*** serve as "body parts" of MB, and one can speak about magnetic motor actions. Besides concrete motion of flux quanta analogous to ordinary motor activity, basic motor motor actions include the contraction of magnetic flux tubes by a phase transition reducing Planck constant, and the change in thickness of the magnetic flux tube changing the value of magnetic field and thus the cyclotron frequency. Reconnections of the flux tubes allow two MBs to get in contact and temporal variations of magnetic fields inducing motor actions of MBs favor the formation of reconnections. Flux tube connections at molecular level bring a new element to biochemistry allowing to understand bio-catalysis. Flux tube connection serves as a space-time correlate for attention in TGD inspire theory of consciousness.

- ***Cyclotron Bose-Einstein condensates*** of various charged particles can accompany MBs. Cyclotron energy $E_c = hZeB/m$ is much below thermal energy at physiological temperatures for magnetic fields possible in living matter. In the transition $h \to h_{eff}$ E_c is scaled up by a fractor $h_{eff}/h = n$. For sufficiently high value of h_{eff} cyclotron energy is above thermal energy $E = h_{eff}\, ZeB/m$. Cyclotron Bose-Einstein condensates associated with MBs of basic biomolecules and with cell membrane proteins - play a key role in TGD based biology.

- ***Josephson junctions*** are between two superconductors. In TGD the notion generalizes: ***generalized Josephson junctions*** accompany membrane proteins such as ion channels and pumps. A voltage between the two super-conductors implies ***Josephson current***. For constant voltage the current is oscillating with ***Josephson frequency*** . Josephson current emits ***Josephson radiation***. The energies come as harmonics of ***Josephson energy***.

  In TGD generalized Josephson radiation consisting of dark photons makes communication of sensory input to MB possible. The signal is coded to the modulation of Josephson frequency depending on the membrane voltage. The cyclotron Bose-Einstein condensate at MB receives the radiation producing a sequence of resonance peaks.

- ***Negentropy Maximization Principle*** (NMP). NMP [K7] [L76] is the variational principle of consciousness and generalizes SL. NMP states that the negentropy gain in SFR is non-negative and maximal. NMP implies SL for ordinary matter.

- ***Negentropic entanglement*** (NE). NE is possible in adelic physics and NMP does not allow its reduction. NMP implies a connection between NE, dark matter hierarchy, p-adic physics, and quantum criticality. NE

is a prerequisite for an experience defining abstraction as a rule having as instances the state pairs appearing in the entangled state.

- ***Zero energy ontology (ZEO)*** In ZEO physical states are pairs of positive and negative energy parts having opposite net quantum numbers and identifiable as counterparts of initial and final states of physical event in the ordinary ontology. Positive and negative energy parts of the zero energy state are at the opposite boundaries of ***causal diamond*** (CD, see **Fig. 9**)) defined as a double-pyramid-like intersection of future and past directed light-cones of Minkowski space.

  CD defines the "spot-light of consciousness": the contents of conscious experience associated with a given CD is about the space-time sheets in the imbedding space region spanned by CD.

11 Appendix B: Figures

11.1 Basic TGD

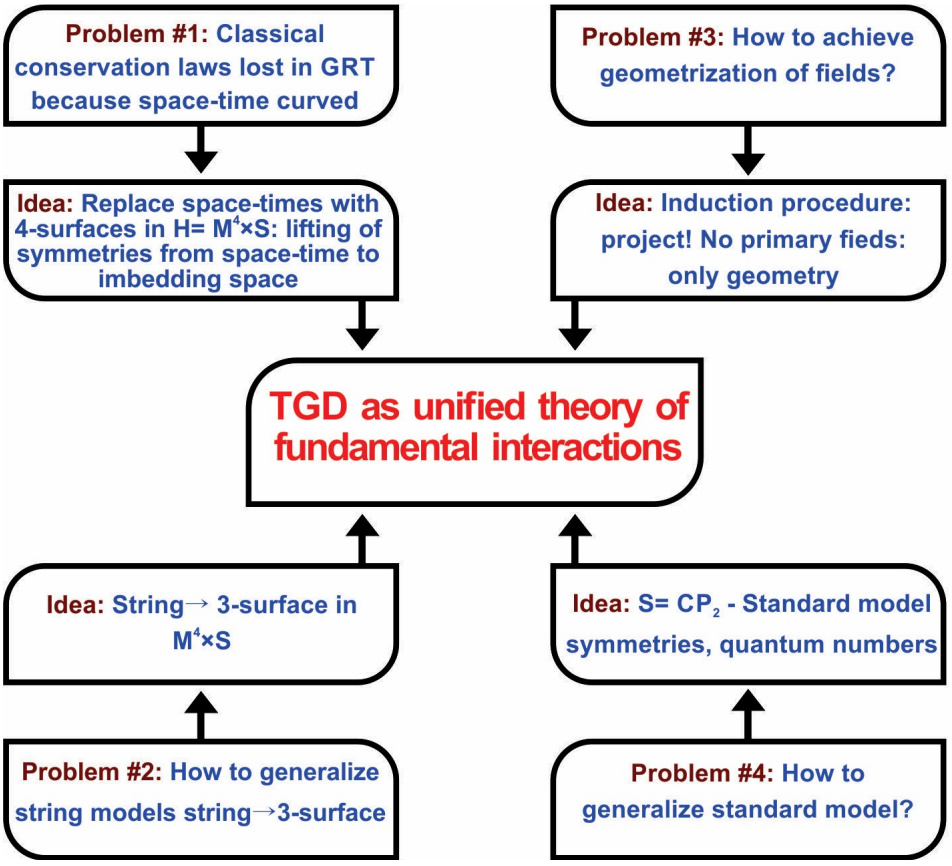

Figure 1: The problems leading to TGD as their solution.

11.2 TGD inspired theory of consciousness

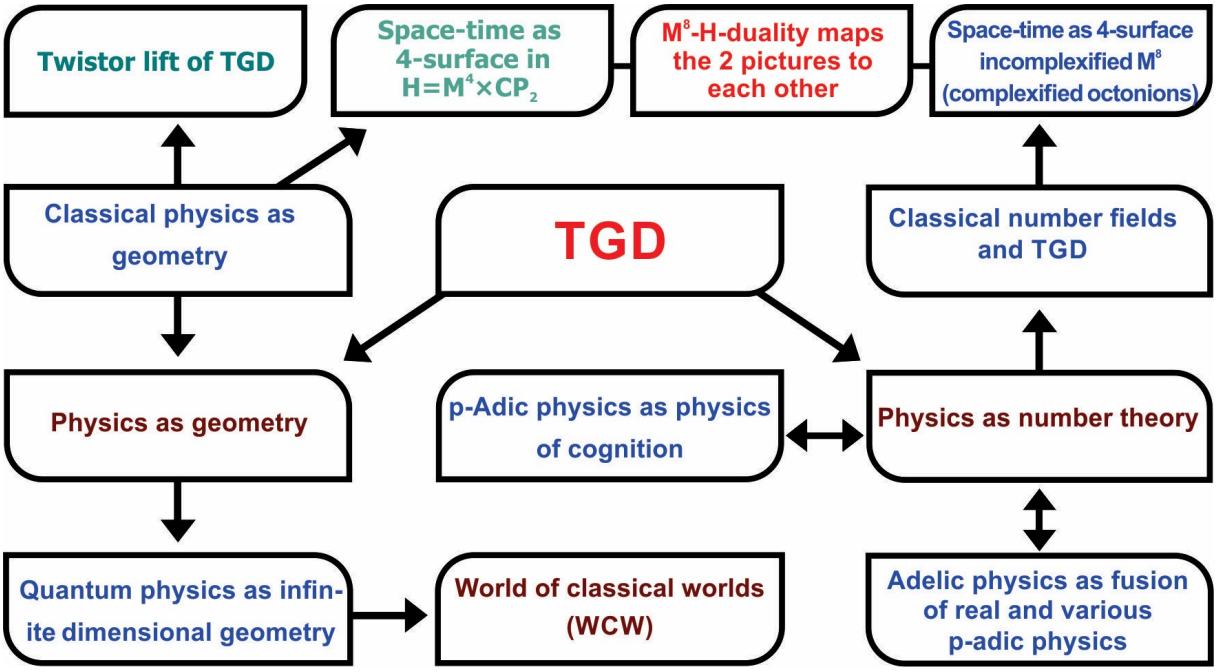

Figure 2: TGD is based on two complementary visions: physics as geometry and physics as number theory.

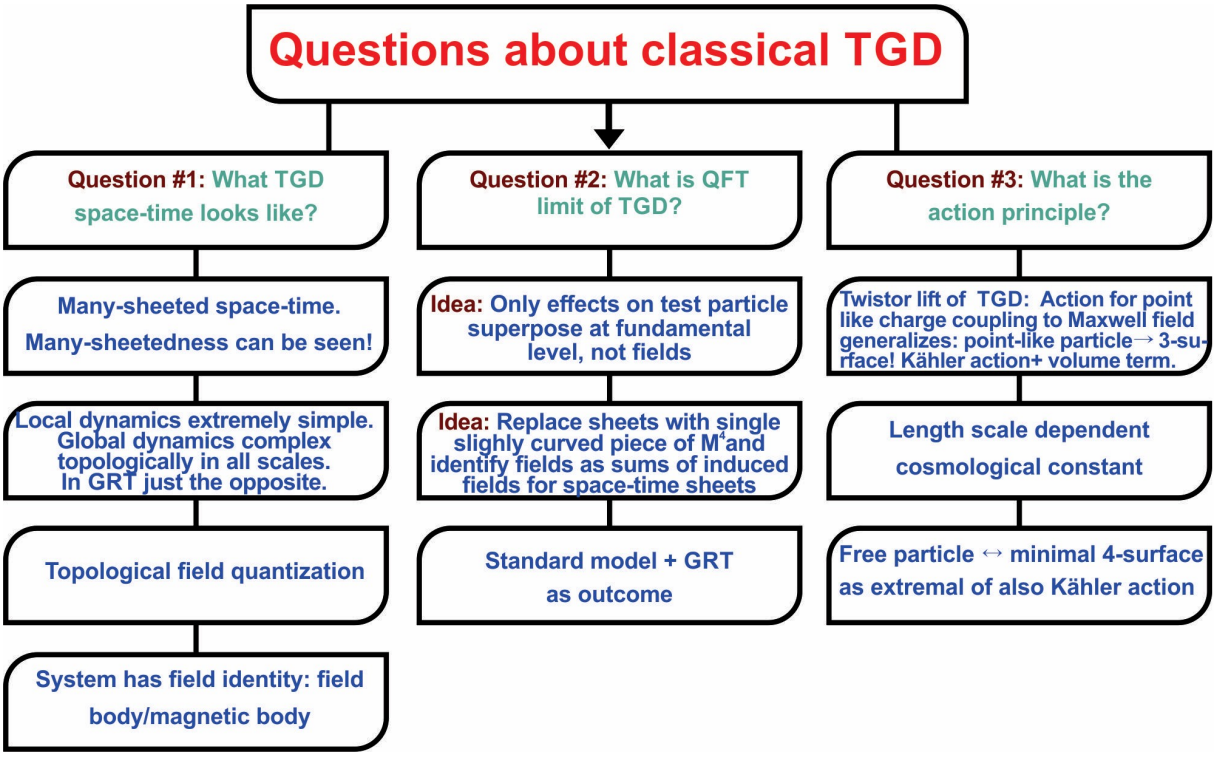

Figure 3: Questions about classical TGD.

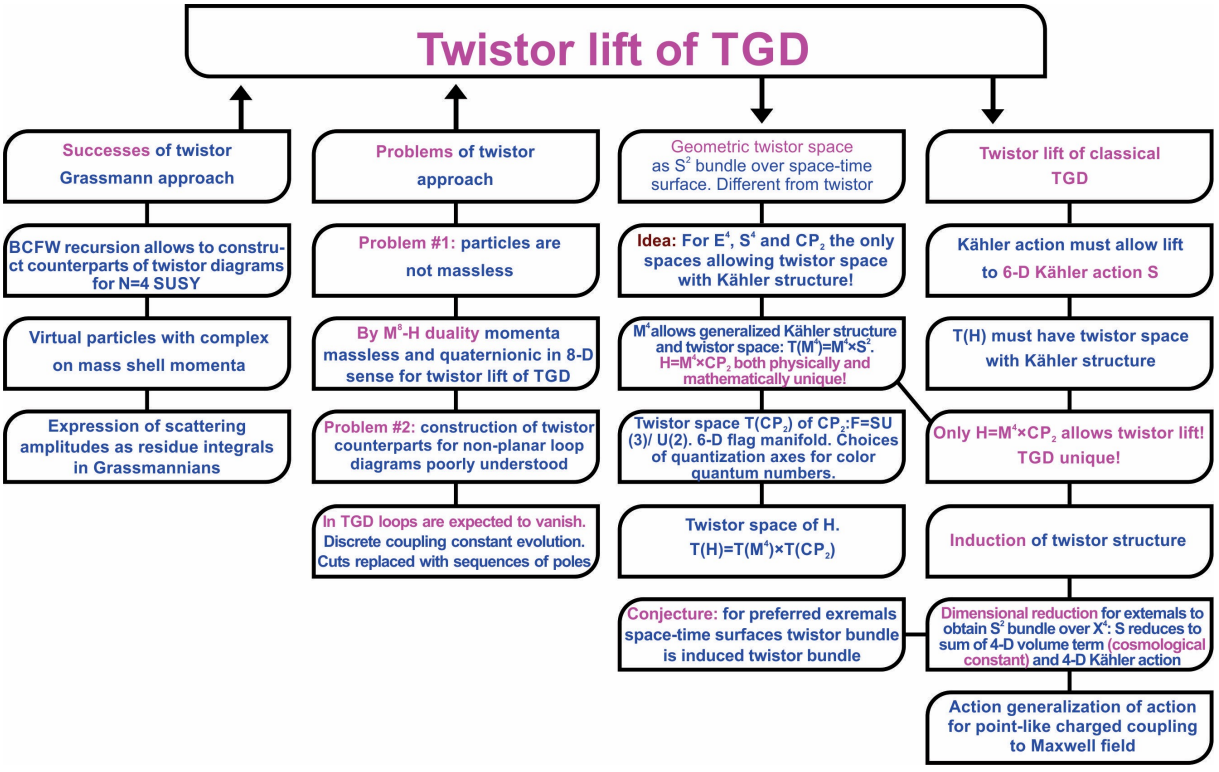

Figure 4: Twistor lift

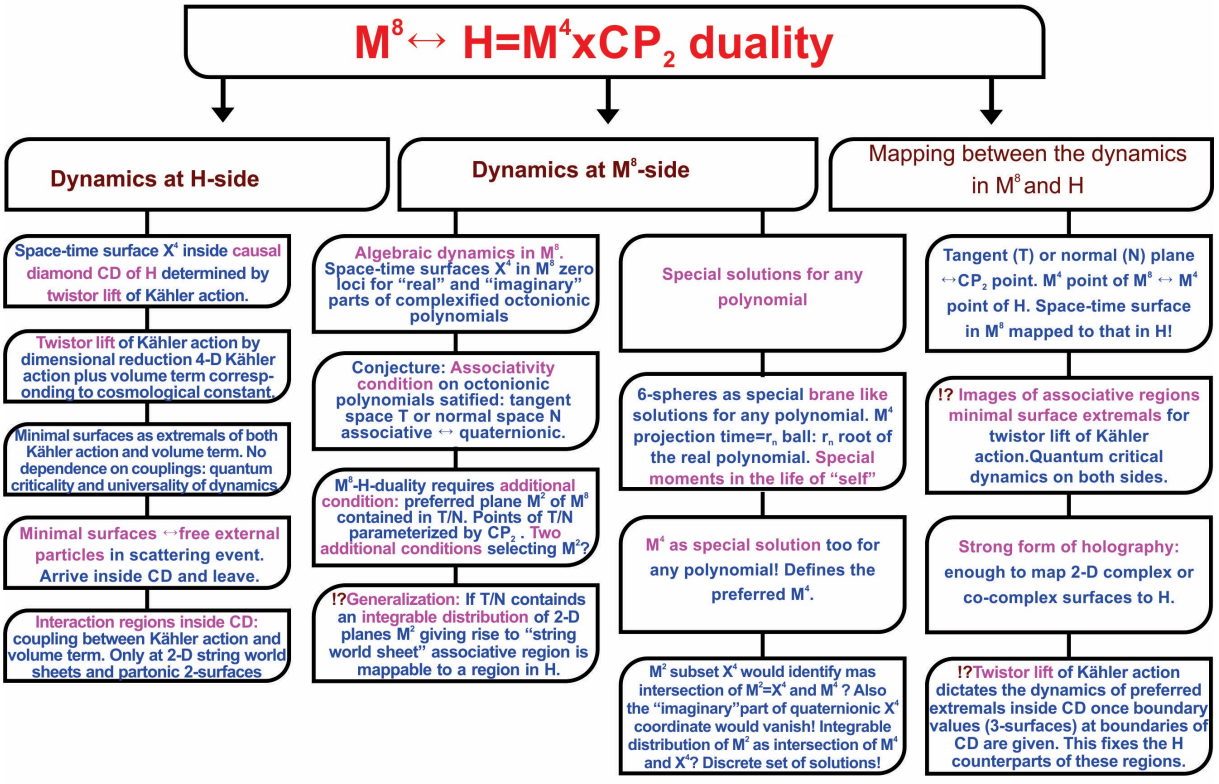

Figure 5: $M^8 - H$ duality

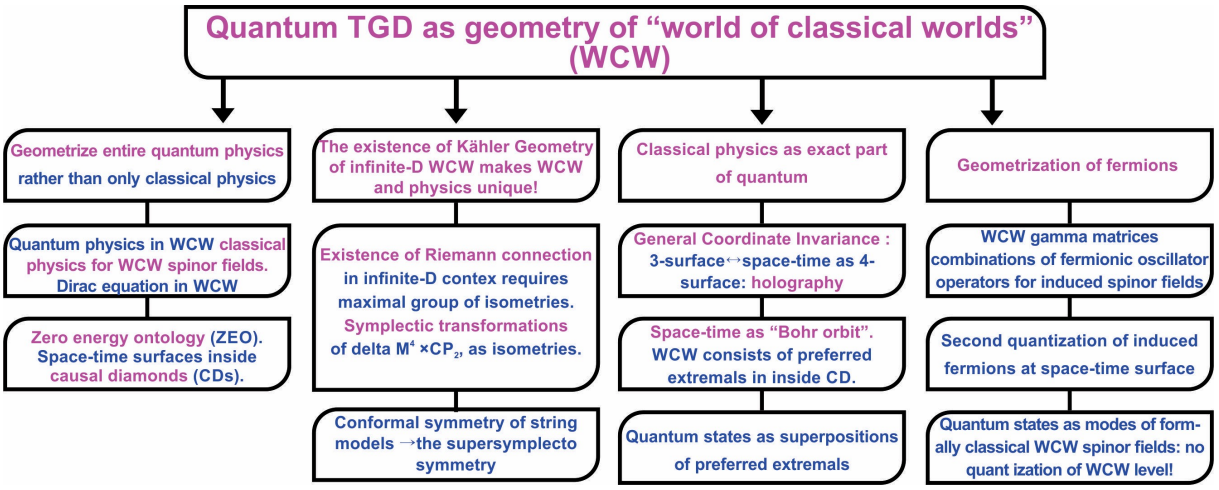

Figure 6: Geometrization of quantum physics in terms of WCW

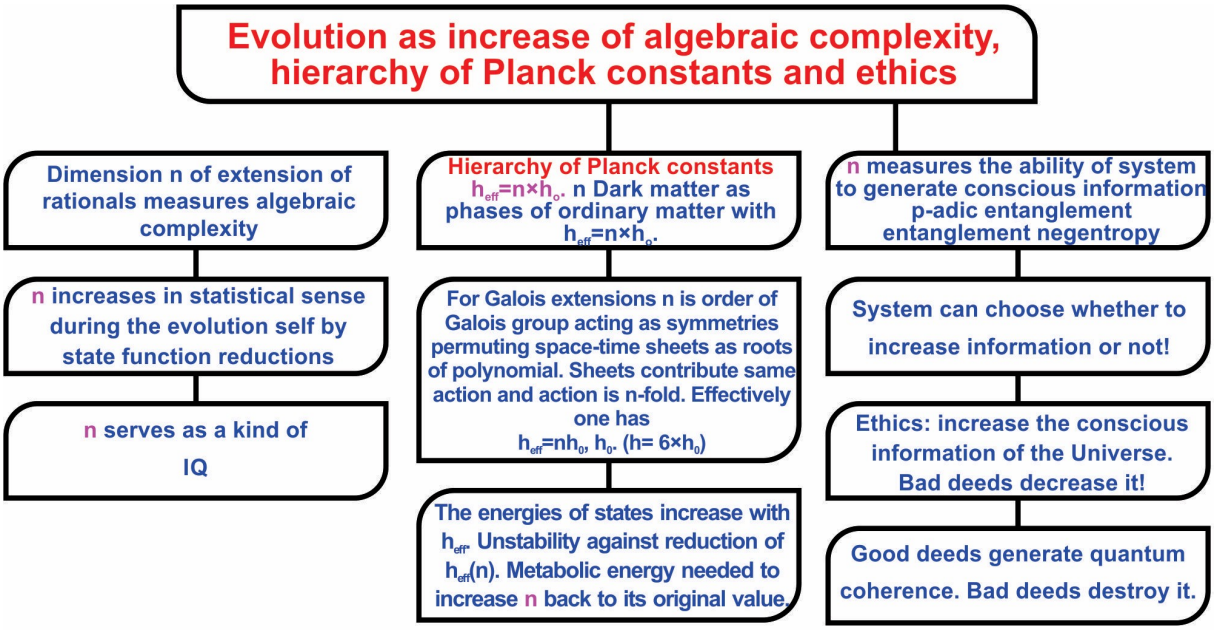

Figure 7: Number theoretic view about evolution

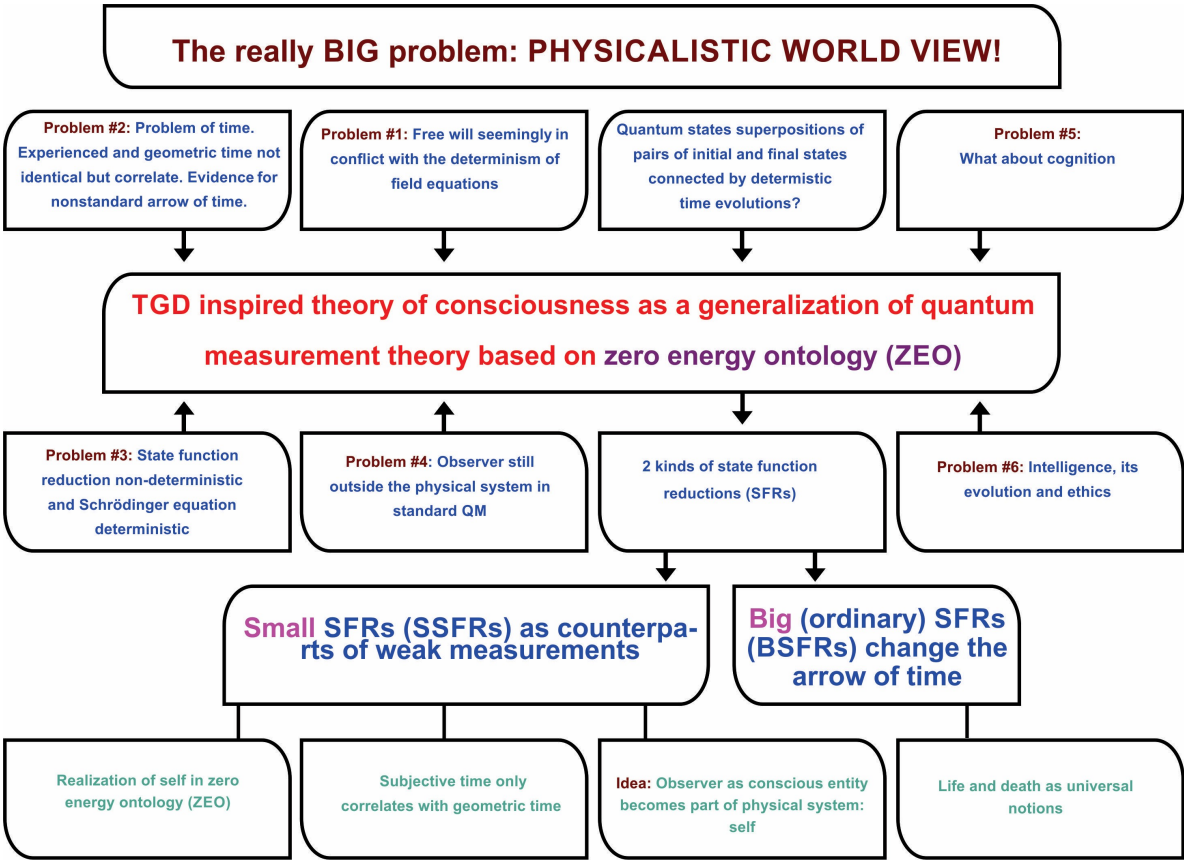

Figure 8: Consciousness theory from quantum measurement theory

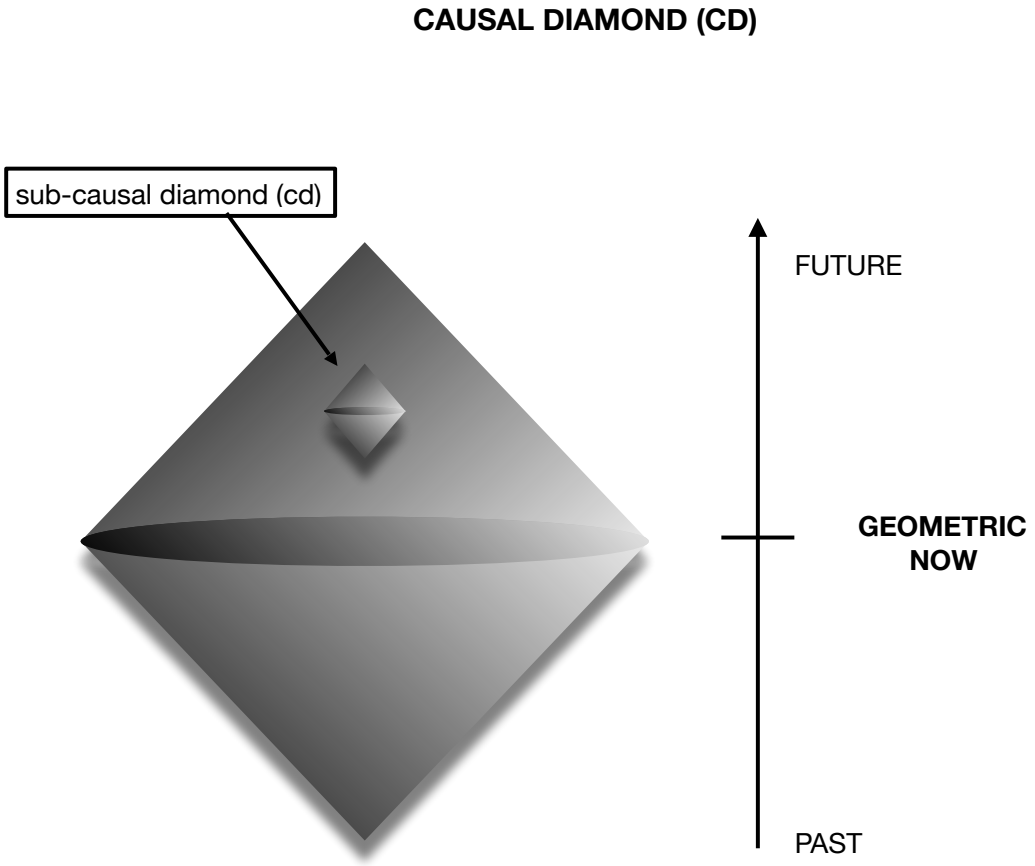

Figure 9: Causal diamond

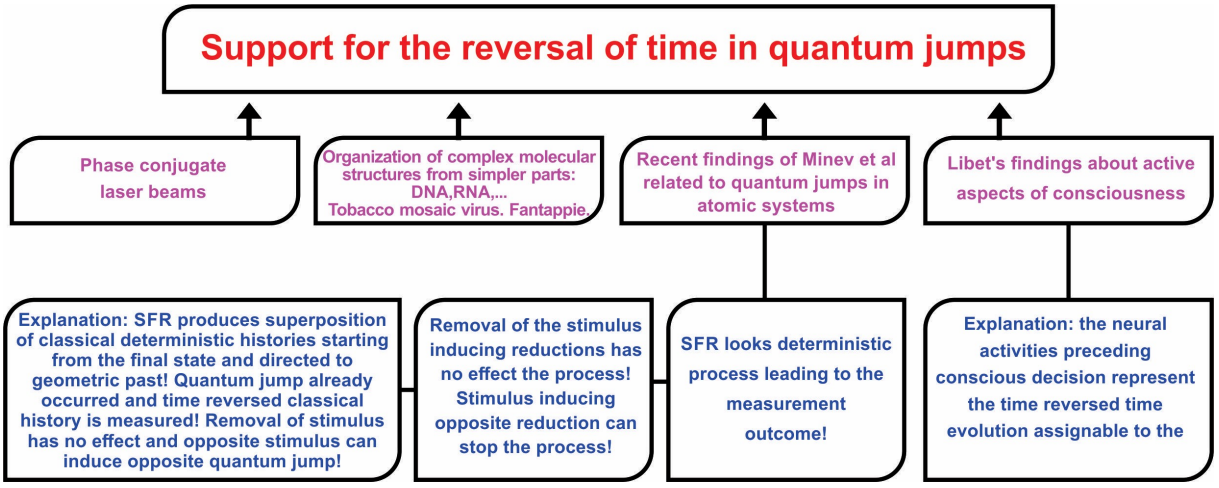

Figure 10: Time reversal occurs in BSFR

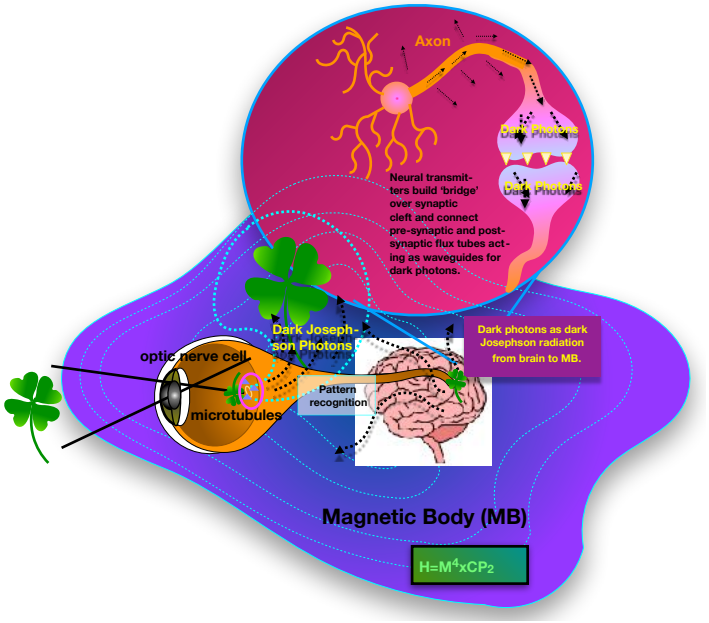

Figure 11: Dark Josephson photons communicate sensory data to the "big" part of MB. Also the forth-and-back communications between sensory organ and brain use dark photons.

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