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 do not provide objective proof.

The situation changes 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 theory predicting that consciousness, life and death are universal phenomena. The theory relies on new views of 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 of 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 including not only reals but also p-adic number fields. 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 at arbitrarily long scales. Theory makes testable predictions at all scales supporting the proposed view of the continuation of life beyond biological death. 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 do not offer 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) [L54], 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. Zero Energy Ontology (ZEO) [L68] solves the basic problem of quantum measurement theory and extends quantum measurement theory to a theory of consciousness. The observer is repositioned from an outsider to an intrinsic part of the 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 to the ordinary state function reductions (SFRs). What is new is that in the BSFR the self re-incarnates with an opposite arrow of time (AT). Life corresponds to a sequence of "Small" State Function Reductions (SSFRs) in which AT does not change. SSFRs are analogs of "weak" measurements analogous to classical measurements (`http://tinyurl.com/zt36hpb`).

2. A number theoretic view of cognition generalizes real number based physics to adelic physics [L22, L23] involving not only reals but also p-adic number fields and their extensions. One outcome is the identification of dark matter as phases of ordinary matter labelled by extensions of rationals (EQ). The dimension n of EQ is identifiable in terms of the effective Planck constant $h_{eff} = nh_0$ ($h = 6h_0$ is suggested by the findings of Mills [D3] [L25]).

   EQ induces extensions of p-adic number fields serving as correlates of cognition. [L22, L23]. " n" measures the algebraic complexity of these extensions and therefore a universal measure for the level of cognition not restricted to human brain or even living matter. " 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. TGD provides a new view of space-time, classical gauge fields, and gravitational fields. The identification of space-time as a 4-D surface in certain

8-D space-time fixed by the standard model (SM) symmetries leads to a geometrization of the classical fields and their elimination as primary dynamic 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 notions of a field body (FB) and its special case *magnetic body* (MB) are 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 separate 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" (algebraic complexity measured by $n = h_{eff}/h_0$), 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 in all its variety 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 posed in this 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 plan of the article is as follows:

1. Section 1: TGD as a solution of the energy problem of GRT by replacing the Einsteinian space-time with 4-surface or as a generalization of string models by replacing string world sheets with 4-surfaces; the dual views of TGD reducing physics to geometry or to number theory; examples of applications.

2. Section 2: TGD inspired theory of consciousness as a generalization of quantum measurement theory based on ZEO and negentropy maximization principle (NMP).

3. Section 3: TGD inspired quantum biology relying on the notions of MB and dark matter as a hierarchy of phases with effective Planck constant $h_{eff}/h_0 = n$.

4. Section 4: TGD view of the brain.

5. Section 5: Aging and death understood in ZEO as universal phenomena.

6. Section 6: Evidence for life after death in the TGD Universe.

7. Section 7: A model for biological death and near death experiences (NDEs).

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
AB: active boundary of CD PB: passive bounddary of CD SFR: State function reduction
BSFR: "Big" (ordinary) SFR
SSFR: "Small" SFR
NMP: Negentropy Maximization Principle
SL: Second Law of thermodynamics
AT: Arrow of time
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 on which I have worked for the past 43 years. The books "Topological Geometrodynamics"(2006) [K11] and "Topological Geometrodynamics: Revised Edition" [K16] provide summaries of the theory of TGD. The book "Life and Consciousness: TGD based vision" (2014) [K15] describes a TGD inspired theory of consciousness. The article "Philosophy of adelic physics" (2017) [L22, L23] describes a number theory based vision of 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 [L59, L60, L61].

The article "Summary of Topological Geometrodynamics" (2020) [L65] provides the the most recent summary of TGD with illustrations. My CV (`https://cutt.ly/3bJ2aSm`) contains a list of published articles, books, and online books about TGD. A list of online articles can be found at `https://cutt.ly/ZbJ2s75`.

2.1 The basic problem and idea behind TGD

TGD relies on a new view of space-time inspired by the problem of GRT due to the loss classical conservation laws (the "energy problem"). Matter makes the flat Minkowski space M^4 of Special Relativity (SRT) curved so that it loses Poincare transformations as 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 SM: color symmetries correspond to the isometry group $SU(3)$ and electroweak symmetries 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 of color makes it possible to identify leptons as local 3-quark composites [L49, L48, L40, L59, L69] so that only quarks are needed as fundamental fermions. The mystery of matter-antimatter symmetry would thus be solved: leptons correspond to antimatter and baryons to matter.

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

2.2 Physics as geometry and physics as number theory

TGD decomposes to two basic threads: physics as geometry [L3, L2, L10, L52] and physics as number theory [L27, L28, L23] (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 an analog of Maxwell action. This action is predicted by the twistor lift of TGD [L18] (see **Fig. 6**).

   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 t 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 [L60, L61] (see **Fig. 7**).

These approaches are related by the $M^8 - H$ duality [L60, L61] (see **Fig. 7**) for which weak and strong forms can be considered.

1. The identification of M^8 as an analog of 8-D momentum space as cotangent space of $M^4 \times CP_2$ represents the most recent step in this progress [L60, L61, L72].

2. One can realize both weak and strong forms of $M^8 - H$ duality in M^4 degrees of freedom by an inversion map $p^k \in M^4 \to m^k = \hbar_{eff} p^k/p^2$ [L60]. This conforms with the Uncertainty Principle (UP) but does not however the full UP. An even stronger form of $M^8 - H$ duality states that momentum p^k is mapped to a union of points $m^k + \delta m^k$, such that $\delta m^k \cdot p_k = n2\pi$ belong to the interior of causal diamond (CD), and would satisfy full UP [L72].

3. The weak form of $M^8 - H$ duality relies on the strong form of holography (SH) which makes it possible 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 [L46].

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 provides a major simplification [L60, L61].

The identification of M^8 as an analog of momentum space generated a breakthrough but also resulted in an objection. Periodic functions and Fourier analysis characteristic for dynamics are absent at the level of M^8. Could 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 are represented as Fourier expansions of M^4 coordinates [L53, L72].

Quantum TGD leads to a generalization of the geometrization of the physics program of Einstein. The entirity of 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. 8**). 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 [L50, L51] 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 [L22, L23] 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 in a universal sense predicted to be present at all scales (see **Fig. ??**) and not restricted to human brain or even living systems as usually understood.

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. This predicts 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. 9**). 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 at 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 an understanding of elementary particles and galactic dark matter and energy [L47, L43].

   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.

   A quantum field theory (QFT) limit for "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 SM gauge potentials are identified as the sums of induced spinor connections of 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 at all scales and this hidden many-sheetedness leads to non-trivial predictions at all scales, in particular, 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 (i.e. real space-time surfaces) and p-adicities implies a strong correlation between cognition and sensory 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 [K11, K15, K16], the article [L22] about adelic physics, and the articles [L24, L35]. The latest mathematical progress is described in the articles [L59, L60, L61, L72]. 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) [L68].

3.1 Conditions satisfied by the theory of consciousness

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

The new theory must solve the basic problems intractable to 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 a strict physicalist, will in their subjective experience, regard free will as real, but in the role of natural scientist, deny it since it is inconsistent with the determinism of classical physics. Could the underlying view of time be wrong? Could free will be consistent with deterministic 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 the time=constant snapshot of time evolution central to the standard ontology.

2. A similar problem plagues quantum measurement theory. The state function reduction (SFR) is non-deterministic whereas 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. A quantum theory of consciousness would generalize quantum measurement theory. The notion of "self" as part of a system would replace that of "observer".

Quantum coherence is assumed to be possible only at very short scales. Coherence of biological systems, however, suggests this assumption is wrong. There is also the question whether there is some scale at which quantum behavior transforms to classical behavior. This question has not been answered. Could the quantum world actually prevail at 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 geometric time: contents of sensory experience correspond to a moment of geometric time within an accuracy of .1 second: one can speak of a sensory chronon. How should 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? Does consciousness survive 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 [L68] leads to a quantum theory of consciousness (see **Fig. 10**). In particular, the theory predicts that the arrow of time (AT) changes in "Big" (ordinary) SFRs (BSFRs) (see **Fig. 13**) as opposed to "Small" SFRs (SSFRs) as the counterparts of "weak" measurements (`http://tinyurl.com/zt36hpb`).

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

1. SO always involves an energy feed. The energies of quantum states increase with $h_{eff} = nh_0$ and h_{eff} tends to be reduced spontaneously. The 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 a space-time surface [L60, L61]. This prevents also the reduction of the scale of quantum coherence. 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 SL 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 [L77]. This inspires a totally new vision, not only of living matter, but also in regards to possible energy technologies.

3. Time reversals occur at 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 ordinary matter as well.

   MB has an onion-like layered structure implied by the p-adic length scale hypothesis [K14] and h_{eff} hierarchy [L39]. Layers have sizes even larger than the size of the Earth. 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 interpreted 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 of consciousness relies on ZEO solving the basic paradox of quantum measurement theory. First, a brief summary of ZEO [L68] is required.

1. The notion of a causal diamond (CD) (see **Fig. 11**) 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-D 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 [**?**])via the $M^8 - H$ duality [L46, L60, L61].

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 (AT) and SSFRs (analogs of "weak" measurements) preserving AT that give rise to an analog of the Zeno effect (`https://cutt.ly/yl7oIUy`) [L68].

To avoid confusion, one may 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 - and assigned 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, external particles arriving 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. A weaker form of this condition [L72] states that the total conserved Poincare charges are opposite only at the limit of infinitely large CD. CD would be an analog of quantization volume in QFTs, whose finiteness implies a small conservation of momentum.

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 time 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 death and reincarnation in universal sense

In BSFRs, AT 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 [L41]. BSFR replaces the 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 AT, the final zero energy state is a superposition of deterministic, smooth time evolutions leading to a fixed 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. The ZEO based interpretation is that a second BSFR as a return back to the initial state occurs.

2. Libet's experiments on the active aspects of consciousness [J6] can be understood from this perspective. For instance, a test subject raises his index finger and neural activity starts *before* the conscious decision to do so. In a physicalistic framework, neural activity leads to the experience of making 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 AT. In the standard direction of time this looks like self-organization which leads from a chaotic state to an 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 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 [L42, L36].

   In biology, the reversals of AT may occur routinely [J22] 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 [L45, L77]. 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 [L64] 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 [L64]. 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. 11**) . The "geometric now" would correspond to the $T_{now} = T/2$ which corresponds to a 3-D ball (not a 2-D sphere, which is its boundary) 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' [L19, L20, L21, L38, L60, L61]. 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.

   This picture applies at the level of H. $M^8 - H$ duality [L60, L61] forces also consider the M^8 level. M^8 is analogous to momentum space: there is no time and space in the usual sense. Could the claims of timeless and spaceless states of consciousness correspond to the M^8 mode? In momentum space, time and spatial coordinates are replaced with energy and momenta.

$M^8 - H$ duality leads to a more detailed picture of 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 $P(o)$ [L38, L60, L61].

   The associativity of the normal space of the space-time surface is the number theoretical dynamic 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 the given CD is infinitely larger than those smaller than it). PB remains unaffected apart from 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 in light.

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 a naive expectation, 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 that learning during the next life cycle with an opposite AT. In the BSFR, AB 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 first describe a 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 defined as the number of items to be found. The participants who knew that the event would 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. Reference [L82] shows 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 [L58]. Only this abstract information can be pre-determined.

   The BSFR for MB_2 above MB_1 in the hierarchy - the "boss" - corresponds to a 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 geometric time very concrete. The fate of the subject person MB_1 is to some degree determined by BSFR of MB_2. With respect subjective (geometric) time, this BSFR occurred *before* (*after*) MB_1 made the prediction.

   This a supports the idea of the organizer of the experiment to perform the experiment was actually communicated by MB_2 to the experimenter. Thus she only actualized her fate.

Could most, if not all, planned actions be like this - induced by BSFR of MB_2 in the geometric future, but in the subjective past (of MB_1)? This would allow for more detailed planning at the level of MB_1. There would be the experience of planning and a realization induced by the signals from the geometric future sent by a higher level in the hierarchy of conscious entities! In long time scales we would be realizing our fates or wishes of higher level conscious entities rather than as 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 MB layers.

2. The 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 proceed to the atomic level.

3. Sensory perceptions and motor actions would be universal. Sensory perceptions naturally correspond to SSFRs "weak" measurements (`http://tinyurl.com/zt36hpb`), and both BSFRs and SSFRs can occur with both arrows of time. Motor action is identifiable as a cascade of BSFRs, with each BSFR inducing sensory perceptions as SSFRs at lower levels. These would, in turn, induce motor actions as BSFRs in shorter time and length scales.

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

Negentropy Maximization Principle (NMP) defines the variational principle of consciousness in TGD [K6] [L74].

1. NMP replaces the 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. Instead of a single measurement, there is a measurement cascade, proceeding from long to short scales. At each step a system decomposes to a pair of unentangled subsystems. NMP states that the negentropy gain in each step is maximized and selects the pair $S_a - S_b$ at each step. This process can be visualized by a tree diagram.

2. In adelic physics [L22, L23] 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. One can also say that NE distinguishes between living and inanimate matter and between dark and ordinary matter.

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

On the basis of empirical facts, Jeremy England [I6] has proposed that SL implies evolution. This statement seems to be in conflict with the standard thermodynamic view of biology [L11].

England's view that SL implies evolution, is clearly in error. NMP [L74] explains why England's paradoxical view is apparently true. A generalization of quantum measurement theory to a ZEO based theory of consciousness, and a number theory based view of cognition leading to adelic physics, is required to understand this misinterpretation.

1. SFR decomposes a given system (unentangled from the environment) to 2 subsystems in such a manner that the negentropy gain is maximal for the the "winning" decomposition. This corresponds to the 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 entanglement and thus to the density matrix. The negative of the ordinary entanglement entropy $N = -S$ defines negentropy which at best is $N = 0$ since N is always non-positive.

   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 also assign to the extensions of p-adic number fields an entanglement negentropy by the analog of a Shannon formula replacing logarithms of probabilities with the logarithms of their p-adic norms [K6] [L74].

   Remarkably, p-adic entropy can be negative and NMP mandates this. Furthermore, its magnitude is not smaller than that of real entropy. Therefore 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 [L11].

   p-Adic number fields, combining with real numbers to form an adele, are needed [L22, L23]. The algebraic extensions of p-adic number fields induced by EQs form an infinite hierarchy with increasing complexity which is identifiable as an evolutionary hierarchy. EQs emerge from $M^8 - H$ duality [L60, L61]. Space-time regions are determined by polynomials defining the EQs via their roots. Evolution as an increase of the dimension of EQ is unavoidable.

3. Consider now the connection with thermo-dynamics. When SFR occurs, entanglement entropy becomes zero, but ensemble entropy increases. That is, the outcome of measurement is not deterministic and reduction probabilities correspond to the eigenvalues of the density matrix. This means an increased thermo-dynamic 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 and replace thermodynamic equilibria for which entanglement negentropy is maximum. The conscious entity maximizes its knowledge during its life-span quite universally: this applies to all systems at all scales, not only humans.

   For $h_{eff} = h_0$, NMP implies standard quantum measurement theory. Entanglement can be also non-negentropic for non-trivial EQs. In this case, 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. This gives rise to a generation of conscious information. In summary, a pessimistic SL transforms to an optimistic NMP and implies SL for ordinary matter.

4 TGD and quantum biology

Often, problems have served as starting points for developments in TGD. This also applies to biology. The following list includes some examples. A more detailed discussion is in [L35].

1. How can one understand the coherence of living systems? If bio-chemistry alone explained life, 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 ordinary coherence? What entities serve as intentional agents and how could they realize their intentions?

2. Why is metabolism needed? Particles with nonstandard h_{eff}/h_0 have a 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 a dimension higher than a given integer n is infinitely larger than the number of extensions with a dimension smaller than n.

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

4. What is morphogenesis? If biology is merely biochemistry, this question remains unresolved. However, if space-time topology is non-trivial at all scales, the situation changes dramatically. All structures - *including bio-molecules, membrane like structures, organelles, organs, etc. - are 4-D space-time surfaces representing dynamic patterns*, and morphogenesis emerges at a classical level in the 4-D sense [L34, L14]. Holography implies that 3-D surfaces are equivalent to corresponding 4-D surfaces as analogs of Bohr orbits. Thus ZEO replaces the ordinary quantum state as a structure with zero energy state as an analog of function, behavior, or program and notions such as 4-D brain emerge. One might even say that structure and function are equivalent.

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 contains dark matter identified, as phases of ordinary matter characterized by EQ with a dimension $n = h_{eff}/h_0$ serving as a measure of the algebraic complexity of a given space-time region [L60, L61], 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 master-slave 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, an energy feed is needed to preserve the distribution of h_{eff}: the interpretation is as an analog of a metabolic energy feed.

MB acts as a "boss" controlling ordinary matter and induces self-organization [L45].

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 a Maxwellian regime. Flux can also be non-vanishing and quantized corresponding to a monopole flux. In the monopole case, the magnetic field requires no current for its creation. This option is not possible in the Maxwellian world. By fractality of the TGD Universe, these flux tubes play a key role at all scales [L43].

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

1. The monopole flux part (see **Fig. 14**) corresponds to the "endogenous" magnetic field $B_{end} = .2$ Gauss and explains the strange effects of ELF EM radiation on the physiology and behavior of vertebrates [J10].

   The presence of this part explains the stability of the Earth's magnetic field. This field should have decayed long ago in a Maxwellian world since it is generated by currents which disappear.The contribution of the molten iron in the Earth's core to B_E decays but the changes of the orientation of B_{end} regenerate it [L56]. Also, magnetic fields that penetrate super-conductors as quantized fluxes and even those of permanent magnets (as opposed to electromagnets) may have a monopole part consisting of flux quanta.

2. The interaction of MB with the gravitational field of Earth is discussed in [L76]. Intriguingly, the metabolic energy currency with the nominal value of .5 eV is rather close to the energy for the escape velocity of a proton. Could the transfer of ions from the surface of the Earth to MB be a standard process?

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 a large h_{eff} and vice versa. Molecular transitions would represent one form of control.

1. Cell membranes could act as generalized Josephson junctions generating dark Josephson radiation with energies given by the sum $E_J + \Delta E_c$ of ordinary Josephson energy E_J and the difference ΔE_c 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 the 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}. h_{eff} should be rather large and possibly assignable to the 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 expected to have discrete spectrum. The energies $E = h_{eff}f$ of dark photons should be in the biophoton energy range (visible and UV) characterizing molecular transitions [K13, K17].

3. For the value $v_0/c \simeq 2^{-11}$, suggested by the Nottale's model for planetary orbits [E1], the predicted cyclotron energy scale is 3 orders of magnitude higher than the energy scale of visible photons. Several solutions of this problem were considered [L75]. The most plausible solution [L75, L70] is $\beta_0 = v_0/c = 1/2$ for living matter so that gravitational Compton length $\Lambda_{gr} = GM/\beta_0$ equals to Schwartschild radius at the surface of Earth. and brings nothing new to the original Nottale hypothesis.

By its higher level of "IQ", MB would naturally be the master controlling BB by cyclotron radiation - possibly via a genome accompanied by dark genome at flux tubes parallel to the DNA strands.

1. Cyclotron Bose-Einstein condensates (BECs) 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.

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

3. In ZEO, the 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 a result of 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 ZEO time reversals of these processes also take place. This makes it possible to understand memory as a result of communications with memory mental images (see section 3.2.3).

4.1.3 Evidence for dark charged particles

The notion of dark matter as a controller of biomatter preceded its justification based on number theory [**?**, L22].

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) assignable to molecular transitions [K13, K17].

2. What makes the large values of h_{eff} possible? Nottale's hypothesis [E1] introduces the notion of the gravitational Planck constant $\hbar_{gr} = GMm/v_0$, whose form is fixed by an Equivalence Principle (EP). In the TGD framework, $h_{eff} = h_{gr}$ is assigned to gravitational flux tubes [L37]. There are non-trivial implications that reflect 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. One cannot exclude lower energies above thermal energy for physiological temperature.

   (b) The gravitational binding energies of a mass m for Bohr orbits around M do not depend on M at all [L76].

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 bonds [L66] (`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 molecules such as proteins containing atoms towards the right end of the rows of the Periodic Table are ideal carriers of metabolic energy. It also explains why ions, such as Ca^{++} involved with the control and communications of the cell membrane with the "large" part of MB and having very large $h_{eff} = h_{gr}$, 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 provides the only possibility in the standard physics model. 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 in heating. An article by Chatterjee et al [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-dynamic 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.

TGD based explanation [L26] could be justified by a resonant coupling of 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 $h = 6h_0$ [L25]. Atomic binding energies are proportional to $1/h_{eff}^2$ and Mills reports that the 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 (PE) [I7] 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 EZ is explained as a formation of flux tubes carrying dark protons, which are interpreted as dark nuclei. Every 4^{th} proton should transform to a dark proton transferred to the flux tubes to explain the observations.

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 the same as for the vertebrate genetic code [L30, L44]. This suggests deep connections between nuclear physics and condensed matter physics, chemistry, and biology, which, in the reductionistic spirit, are considered separate disciplines.

EZs are able to remove impurities from their interior in conflict with the second law of thermodynamics (SL). The TGD based explanation is that the time reversal by BSFR at the level of MB [L68] also induces an effective time reversal in long time scales at the level of ordinary bio-matter.

PE explains the occurrence of a charge separation in living matter. DNA has one negative charge per nucleotide, microtubules are negatively charged, the cell is negatively charged, and ATP carries 3 units of negative charge. Therefore ZEO suggests that PE 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. Reduction and oxidation (the REDOX reaction) could be understood in terms of a transfer of dark electrons associated with valence bonds [L80] (`https://cutt.ly/5f5QrgF`).

2. In biochemistry the density of dark protons would be much higher in PE [I3, I4, I1, I7, I10]. Dark ions could play a key role in TGD based view of biochemistry as the findings of Blackman and others suggest [J10].

4.1.6 Biocatalysis and water memory

Bio-catalysis and water memory [I9] remain mysteries in the bio-chemical approach. MB carrying dark matter could provide the needed mechanisms. Reconnection of flux tubes would be the basic mechanism of bio-catalysis and also explain water memory, which in the TGD framework forms the basis of the immune system [K3].

1. According to the TGD view of catalysis, tentacle-like U-shaped flux tubes associated with MBs of reactants reconnect to a pair of flux tubes connecting the molecules [L33]. 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 the liberation of energy which "kicks" the reactants over the potential wall making an otherwise extremely slow process possible.

2. The physics of water is plagued by anomalies [I9]. TGD suggests an explanation [L29] in terms of flux tubes assignable to hydrogen bonds [L29, L32]. 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 mimic 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 a water cluster and invader molecule [L57]. In this framework water would represent a primitive life form.

4.2 Adelic physics, cognition, and biology

$M^8 - H$ duality [L46, L60, L61] concretizes the number theoretic vision.

1. $M^8 - H$ duality states that space- times are representable as 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 an interpretation as a 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 define representations of G.

2. The wave functions in the set of space-time surfaces obtained by the action of G may be interpreted 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 [L64, L74].

3. Galois confinement [L57] would force n-particle states to behave as coherent units like hadrons do as color-confined states.

4. The model makes rather far-reaching predictions. The decomposition of EQ to an extension of an extension of an extension ... of rationals defines a *finite* 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. Simple groups, whose classification is known, are groups which have no normal subgroups [L74, L72] so that this decomposition is trivial. Cognitive processes such as SSFR cascades are impossible for simple Galois groups - thus thinking as analysis is impossible. Could simple groups classify meditative states (or irreducible ideas as analogs of axioms)?

4.3 Genetic code (GC)

The model of bio-harmony [L8, L9, L44, L55, L71] is essential for the TGD based understanding of what might be called emotional intelligence (whose reality is accepted) and its relations with ordinary intelligence. The surprising outcomes are the connection with GC and the key role of bioharmony in quantum information processing in living matter.

1. The notion of bioharmony relies on icosahedral and tetrahedral geometries. The representation of the 12-note scale as a sequence of quints, reduced by an octave equivalence (notes differing by octave are experienced as equvalent) to the basic octave, defines the harmony for a given Hamiltonian cycle: the 20 allowed 3-chords of the icosahedral harmony correspond to the 20 triangular faces. The symmetries of the harmony are defined by some subgroup (Z_6,Z_4, or Z_2) of the icosahedral group.

2. Genetic codons correspond to dark photon triplets (3-chords of light) defined by the triangular faces of an icosahedron and tetrahedron. The counterparts of amino-acids are identified as orbits of 3-chords under the symmetries of a given harmony.

   Any combination of 3 icosahedral harmonies with 20 chords with symmetries Z_6, Z_4 and Z_2 and of the tetrahedral harmony with 4 chords gives a particular bioharmony with 20+20+20+4=64 chords assignable to DNA codons. DNA codons coding for a given amino acid correspond to the chords at the orbit of the symmetry group. Rather remarkably, the numbers of DNA codons coding for a given amino acid come out correctly.

3. Music expresses and creates emotions. Musical harmony codes for moods and emotions as holistic aspects of music. Bio-harmony with 64 3-chords, would assign the binary, local, aspects of information to the 6 bits of the codon and its holistic, emotional aspects to the bio-harmony. A chemical representation of the genetic code can thus correspond to several moods represented by bioharmony. In contrast with physicalism, emotions would appear already at the molecular level, and would have physical effects that are not reducible to bio-chemistry. This understanding is not possible without using the notion of MB.

The model of bio-harmony requires that the values of B_{end} correspond to those associated with the Pythagorean scale definable by the quint cycle. These frequencies correspond to energies that a molecule must have in order to serve as a basic biomolecule. This criterion could select DNA, RNA, tRNA, and amino-acids.

In the second model of GC [L30], codons are represented as dark proton triplets.

1. The numbers of dark proton triplets turn out to correspond to numbers of DNA, RNA, tRNA codons, and amino acids. The numbers of DNA and RNA codons assignable to a given amino-acid in the vertebrate GC are correctly predicted. Genes would correspond to sequences of dark proton triplets [L44].

2. Dark proton triplet - dark codon - would be analogous to baryon and Galois confinement [L57] behaving like a single quantum unit. The N dark codons of a dark gene would, in turn, bind to Galois confined states of the Galois group of an EQ associated with the sequence of codons. An entire hierarchy of confinements is possible.

3. Galois confinement can be realized also for dark photon triplets and the sequences of N dark-photon triplets representing genes as dark $3N$-photon states. Genes could serve as addresses for 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 dark $3N$-photons transforms to single ordinary photon or $3N$ ordinary photons (biophotons) in dark-ordinary communications.

4. 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.

How could the icosahedra and tetrahedra be realized? Why must one glue them together? This looks aesthetically unappealing. However, surprisingly, both icosahedrons and tetrahedrons appear in, perhaps the simplest honeycomb of the hyperbolic 3-space H^3 (cosmic time = constant hyperboloid). H^3 is also central to special relativity and cosmology [L71]. Dark GC can be realized in terms of both dark protons and photons using this particular tessellation and would be universal. This master tessellation would induce sub-tessellations at the space-time surface, in particular representations of GC at magnetic flux tubes. Also 2-D and even 3-D representations of GC can be considered (i.e. cell membrane and microtubules) [L73].

5 TGD based view of brain

The TGD based view of the brain differs in several ways from the standard neuroscientific model relying on materialism and reductionism [K5, K4]. The notion of

MB as a controller of BB (biological body) forces us to abandon the idea of the brain as the sole seat of consciousness. Also the view of the role of nerve pulses is radically 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 and provide an abstract map of the brain. The structure of MB with levels labelled by EQs partially characterized 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 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 [L58]. That is, functionally similar neurons and also higher level brain structures not near to each other in the brain would be connected to nearby points at 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.

An astonishing finding supports this view. In the lab, 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) [J26]. In [K12, K7] this finding was considered as a support for the view that the brain is analogous to a hologram (The TGD Universe can be seen as a conscious hologram [K1]). It seems, 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 the experiment indeed demonstrated. Neurons would be analogous to RAM in computer science.

5.1.2 Dark photons and communications and control

Communications both inside the central nervous system (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 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 found in CNS. This iteration of back-and-forth communications makes pattern completion and recognition possible.

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 have effects that are not masked by thermal radiation. The brain is known to emit biophotons and they are also associated with axons [K17, K13].

Dark Josephson radiation would make information transfer to MB possible whereas the control signals from the MB would be as dark cyclotron photons. **Fig. 15** 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 (such as ion channels and pumps) which act as generalized Josephson junctions. The sensory input is encoded by the Josephson radiation sent to the "big" part of MB [K2].

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. In sharp contrast with the brain-centered neuroscience orthodoxy, the size scale of this layer of the MB would be rather large (i.e. of the order of c/f_c and given by the circumference of the Earth for the 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 the magnetosphere [L70].

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 Δf_J of the cyclotron frequencies $f_c = ZeB/2\pi m$ for flux tubes at different sides of the neuronal membrane and transverse to it. The modulation of f_J by the nerve pulse patterns [K8, K2, K9] would code for sensory and cognitive information.

4. The frequency modulated dark photon radiation absorbed in cyclotron transitions at MB would generate a sequence of cyclotron resonances at MB, which code for sensory input.

   Already the modulation of the 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 the brain. This picture also applies to other forms of information (there are also basal ganglia inside the brain).

5. 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 act as "negative energy" signals with a reversed AT: two BSFRs are required to re-establish the original AT. 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 membranes could induce nerve pulse patterns.

The number theoretic vision suggests a considerable generalization of the idea of resonant communications [L80]. The model of Galois confinement (GC) based on the notion of bio-harmony [L8, L9, L55, L71] and the notion of GC [L64] suggests that dark $3N$-photon states, analogous to BECs, function as coherent dynamic units.

This inspires the notion of $3N$-resonance. Genes could be represented as sequences of N dark photon "3-chords" serving as addresses in dark $3N$-photon communications [L55, L71]. This picture leads to a model of human language [L78, L79].

5.2 A new view of sensory perception

The identification of sensory organs as seats of sensory qualia and a new 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 the TGD view, sensory perception generates sensory mental images at sensory organs rather than in the brain [L31]. This could solve some of the basic problems in neuroscience due to the similarity of neural tissue in various sensory areas. The basic objection is phantom limb syndrome. 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 could solve several mysteries in neuroscience. The stimulation of temporal lobes indeed generates sensory memories, and people with cognitive impairment are known for memory feats such as being able to draw a building, seen in the past, in fine detail, or to learn entire works of music from a single listening.

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

2. The "obvious" interpretation would be that a beam of dark photons travels to the geometric *past*, is reflected back and produce memories as an analog of ordinary vision. Memories would be in the geometric past. However, on further consideration, the process seems to be more complex.

3. It is possible to build a rather detailed model for sensory memories [L62, L63] based on three ZEO and the notion of CD (see **Figs. 11** and **12**) as a perceptive field of self at the level of imbedding space. A crucial element is the identification of the geometric correlate of the "subjective now" (T_{now}) as the 3-D 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 shifting to the 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 a universal sense, these memories would become "silent wisdom" for the next life cycle with an opposite AT. Computer scientists would refer to this function as construction of log files.

5.2.2 New view of 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 of sensory organs requires back and forth signaling between the brain and sensory organs. There should be a virtual sensory input from the sensory areas of the brain, or from MB via the brain, to sensory organs.

A sensory percept would be an actively constructed work of art, a standardized mental image, which is as near as possible to the sensory input. Pattern recognition would occur when the constructed pattern is sufficiently close to a standardized mental image.

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

The TGD view of 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 construction of "waveguides" for dark photons as connected flux tubes from axonal units [L31] [K8]. Nerve pulse patterns at the level of the brain would build standardized cognitive representations by decomposing the sensory input into "named" objects of a perceptive field from which associations could be built.

Sensory organs are seats of sensory qualia and sensory perception. This model explains REM dreams, hallucinations, and psychedelic experiences as experiences involving only the virtual input. Imagination can be understood as an "almost sensory" experience.

More concretely:

1. Sensory mental images at the level of sensory organs are generated by an iteration involving the virtual sensory input from the brain to the sensory organs [L31]. Pattern recognition is realized as a carving of a 4-D work of art representing a standardized mental image as near as possible to the original sensory input. **Fig. 15** illustrates the back and forth communications of sensory data between sensory organ and brain using dark photons.

2. Nerve pulses would connect existing flux tubes parallel to axons to form longer flux tubes: neurotransmitters at synaptic contacts would act as relays. There is an obvious analogy with an old fashioned telephone network. It would requiree too energy to keep all connections on all the time.

   The meridians assigned with acupuncture network could correspond to a permanent flux tube network and would not require nerve pulses, transmitters, nor information molecules as relays. For CNS, this flux tube network would be dynamic. Plants would only have the meridian system.

3. The standard view of learning as a strengthening of synaptic connections translates into a gradual build-up of long-lived flux tube connections, which make

possible dark photon communications. The sender and receiver neuron groups can also fuse to a single, quantum entangled, system.

4. Actually all information molecules (neural transmitters, hormones, and messenger molecules) could be connection builders. An alternative view is that information molecule such as hormone is attached to the end of a flux tube, which stretches as the molecule travels to the target.

   The same theory applies to water memory [K3], which remains a dismissed concept in mainstream science although the research performed outside the confines of institutional support has revealed much about the involved mechanisms.

5.2.3 Dreams, hallucinations, and imagination

TGD makes it possible to understand sensory imagination as virtual sensory inputs from MB via the brain, which do not reach sensory organs. Imagined motor actions as virtual motor actions would not reach muscles.

Virtual sensory inputs would be received by virtual sensory organs inside the brain. A good candidate is the basal ganglia. Ganglions are also associated with sensory receptors. The input from MB or brain would be represented as dark photons.

The notions of virtual sensory and motor input are central to the understanding of speech comprehension and also inner speech. Hallucinations, psychedelic experiences and REM dreams (motor activities during sleep) could be understood as virtual sensory (motor) inputs reaching the sensory organs (muscles). Memory recall could involve virtual (real in the case of sensory memories) sensory input from MB at which memory mental images are realized [L68, L38].

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.

"Geometric now" corresponds to the $T_{now} = T/2$ slice of CD (see **Fig. 11**) with maximal size located in the middle of the CD. If one accepts $M^8 - H$ duality [L46] "geometric now" corresponds to a "special moment in the life of self" [L46, L67] identifiable as intersection of the space-time surface and a 6-sphere which is a brane-like entity (in the sense of branes encountered in M-theory) appearing as a universal special solution to algebraic equations determining the space-time surfaces in M^8_c. The special values of T_{now} would correspond to the roots of the real polynomial defining the space-time surface.

2. During the sequence of SFRs, AB shifts towards the geometric future and the size of CD increases (in the statistical sense). The sub-CDs accompanying sensory and other mental images shift in the direction of the geometric future as CD increases during the SFR sequence 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 Minkowski time t but the order is opposite to the order of subjective experiences. This makes possible for the time-reversed re-incarnate to have these memories as "silent wisdom". Snapshots correspond to subselves to which memory recall builds a connection by entanglement or by sending a signal, reflected back in a BSFR of the memory mental image.

How are episodic memories recalled in ZEO?

1. Spontaneous memory recall could correspond to the death of a memory mental image (sub-self/sub-CD) having the same AT as self (CD) followed by reincarnation with an opposite AT. This would be accompanied by an emission of a past directed "negative energy" signal received by the self associated with the "geometric now". The interpretation is as an extraction of metabolic energy: memory recall indeed requires metabolic energy.

   Active memory recall could correspond to the receipt of a future directed "positive energy" signal by memory mental image arriving from the "geometric now", and allow interpretation as a metabolic energy feed. Reflection of the signal in opposite time direction requires BSFR. Why should BSFR happen? Could the metabolic energy feed induce (by NMP) rapid evolution and aging of the memory mental images leading to its death by BSFR.

2. The prediction is that in an active memory recall by a "positive energy" signals received by the memory sub-CDs (see **Fig. 11**), the order of recalled memories is opposite to that of the original experience. There is evidence for this kind of change [J23] (see also the popular article at `http://tinyurl.com/y7hbqmug`).

6 Aging and death from TGD point of view

ZEO based vision is that aging and death are universal phenomena and that death is followed by a reincarnation with a reversed AT.

6.1 Aging as approach of MB and BB to thermal equilibrium

The book "Lifespan" by Sinclair and LaPlante [I2] proposes that aging corresponds to an approach to epigenetic chaos. The book also proposes that bio-information is not only associated with DNA and GC but also the conformational degrees of DNA and that these are crucial in epigenesis. This vision serves as the starting point of a TGD inspired view of aging written with Reza Rastmanesh [L81].

In adelic physics, NMP [L74] replaces the second law (SL) but implies SL. MB carries dark matter and controls dynamics. Its quantum coherence induces non-quantum coherence of ordinary biomatter. The dissipation of a subsystem with a reversed AT looks like self-organization (SO) from the point of view of the outsider. Also self-organized quantum criticality (SOQC), which is difficult to understand in ordinary thermodynamics, can be explained.

The basic idea is that at birth the temperatures of the MBs of the information molecules are very low but gradually they approach the physiological temperature near the Hagedorn temperature T_H [B1] defining the maximal temperature of MB. T_H is determined by string tension as the energy density of the flux tube and much lower than T_H in superstring theory or in the hadronic string model.

The thermalization leads to epigenetic chaos implying that the flux tubes carrying dark DNA and therefore also ordinary DNA, become looped. 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 collapse.

6.2 What death as BSFR looks like to an outsider?

One can enote the moment of geometric time associated with BSFR of a dying and reincarnating system by T; the dying system before death as S and its time-reversed reincarnate after death as R. Consider an outsider, labelled O. Refer to the AT of O, opposite to that of R, as standard AT. How does O see 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 now" of O so that the death of S, which has taken place with respect to the subjective time of O is located in the geometric future of O.

The time evolution of R allows classical signals to propagate in a non-standard time direction. This could explain the reported strange events preceding the death of a close relative or a friend. In neuroscience, the analog for this is what happens in Libet's experiments involving active aspects of consciousness [J6]. The brain receives a time reversed signal arriving from the geometric future. This signal is interpreted in the standard picture as a readiness potential.

Although BSFR is a discontinuous change with respect to subjective time, ZEO implies that O sees the outcome of BSFR of S as an average over continuous and deterministic time evolutions with the standard AT leading to its death. The outcome for a single time evolution is actually the initial state of a time reversed time evolution of R.

Dissipation with the reversed AT is a conspicious thermo-dynamic anomaly implied by BSFR. For O, this looks like SO, which involves generation of gradients. In particular, the extraction of energy from the environment manifests as a cooling of the environment [L77]. It may be possible to test this prediction.

6.2.2 Death as seen by an outsider after moment T

The life of the R increases its CD in an opposite direction of time (see **Fig. ??**). The CD of R eventually remains in the geometric past of those still alive. What happens in the region of space-time surface in $H = M^4 x CP_2$ in the future of the CD of R?

What O 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". The layers of MB corresponding to the lower levels of the hierarchy are also expected to disappear. The decay of the organism continues down to the lowest molecular levels.

Note that 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 a captain" means that the CDs in the personal hierachy of CDs cease to increase in size by SSFRs as they suffer BSFR.

Physically the loss means that dark photon radiation from BB providing metabolic energy to the highest control level of MB is not needed anymore and dark photons leak out as biophotons. The same happens at all levels as death proceeds to smaller scales.

Direct evidence here is the biophoton emission from dying plants, which intensifies and is used to deduce the vegetable age.

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 AT and continue to live as a conscious entity with a reversed AT. Selves thus live back and forth in geometric time. Experience from the previous life cycle would be represented as "silent wisdom" at the passive boundary of CD (PB), and experienced as mental images which need not be directly 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 over considerably longer spatio-temporal scales than for ordinary matter with $h_{eff} = h$ and induces an effective time reversal at the lower levels. This makes it possible to assign 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 at all scales. This makes it possible to test the theory if these general assumptions are accepted.

1. Time reversal implies that the thermo-dynamic AT for some layers of MB is non-standard. This can induce thermo-dynamic anomalies at the level of ordinary matter. Already Fantappie [J22] proposed that time reversal is common in living matter and introduced the notion of syntropy as time reversed entropy.

   To O, dissipation with a reversed AT looks like a development of various kinds of 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. This might explain anecdotal reports of eerie, cool spaces, where ghosts are said to be present.

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

2. SO could be induced, not only by an active energy feed, but by a time reversed dissipation of the ordinary bio-matter induced by MB [L45]. There is evidence that living systems are quantum critical systems [I8]. In TGD, the entire Universe is quantum critical in the sense that the values of the fundamental coupling constant (Kähler coupling strength), are analogous to critical temperatures.

   Self-organized criticality (SOC) is a phenomenon difficult to understand in standard physics. Criticality is, by definition, unstable since the critical degrees of freedom act as repellors of dynamics. Even the smallest perturbation can lead far away from the repelling point. If the arrow of time is reversed, the repeller becomes an attractor and the system tends to stay near criticality. This would give rise to self-organized quantum criticality (SOQC) [L77].

7.2 Examples about BSFR and death in various scales

Some examples about BSFR as the death of a conscious entity in various scales are in order.

7.2.1 Pollack effect and time reversal

The generalization of the Pollack effect (PE) [I3, I1, I10, I7] plays a key role in TGD inspired biology.

1. As previously explained, PE occurs in the presence of an energy feed such as IR photons, and means a charge separation in water bounded by gel, forming a negatively charged exclusion zone (EZ).

2. EZ has a strange property of driving out impurities: this is a thermodynamic anomaly (along with charge separation). The interpretation is that AT is changed at MB controlling EZ and induces an effective change of AT at EZ differing from the standard AT of an observer positioned outside.

In the TGD framework, PE also generalizes 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 nucleotide involves a negatively charged phosphate ion. This suggests that DNA strands are accompanied by parallel magnetic flux tubes which carry dark proton triplets as a representation of genetic codons [L15, L44, L55].

2. The cell interior is negatively charged, which suggests similar charge separation with the positive charge assignable to dark ions at the magnetic flux tubes outside the cell. Bosonic ions such as Ca^{2+}, Mg^{2+}, Fe^{2+} and Cooper pairs

of fermionic ions such as K^+, Na^+,.. could form Bose-Einstein condensates (BECs). Also negatively charged ions, such as Cl^-, could form BECs at flux tubes.

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

7.2.2 BSFRs and homeostasis as self-organized quantum criticality

The article "*Homeostasis as self-organized quantum criticality*" [L77] represents an attempt to understand the properties of cold shock and heat shock proteins (CSPs and HSPs). Since these proteins are similar, it may be preferential to talk about stress proteins (SPs) as having two different operational modes.

The problem of understanding the behavior of SPs turns out to be only one particular facet of a more general problem: how is self-organized criticality (SOC) or even a quantum variant of SOC (SOQC) possible? Kauffman represented empirical evidence for quantum criticality at the level of bio-chemistry [I8]. As previously explained, ZEO leads to a theory of SO and of SOQC.

In fact, living systems as a whole may be quantum critical and manage to stay near criticality, which means that SOQC could be interpreted as homeostasis central for life. 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 the dissipation with a reversed AT driving the system towards quantum critical configuration.

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

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

In the geometric future of a given CD, the decay process occurs and is followed by a generation of the self corresponding to the next CD in the sequence: this self must be distinguished from time-reversed re-incarnate in its geometric past. 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 associated with these kinds of life forms. There is indeed evidence that the first half of the EEG period is ordered and the second half is chaotic [J17]. The single EEG half period as a counterpart to 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.

7.3 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 also suggests other evidence.

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 the TGD point of view in [K13], suggests that mental images arise and die. The reincarnation ofa mental image as an after image is analogous to "ordinary" reincarnation and is distinguished from re-incarnation with a reversed AT. The mental images would shift to the geometric future of the "geometric now" and repeat their karmic cycle and experience 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 a sensory input and generate sequential after images.

8 Near-death experiences (NDEs)

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

Raymond Moody, the pioneer of NDE, wrote "Life after Life" (1975) [J28] consisting of interviews with NEDrs. Two accounts by medical professionals about personal NDE convinced them that the standard neuroscience view of NDE was wrong. Books by Mary Neal [J24] and by Eben Alexander [J12] conveyed a similar message.

NDE can be studied scientifically. The article by Lichtfield [J20] summarizes the empirical reseach. Retrospective reseach relies on interviews of NDErs and its scientific soundness may be questioned: memories many years after NDE are not reliable and a documentation about the state of the NDEr during NDE is missing. However, prospective studies can be made in hospitals so that documentation regarding patient status is contemporaneous. Interviews can be made immediately after NDE. It is even possible to test various claims such as autoscopy (seeing oneself from outside).

A book edited by Janice Miner Holden, Bruce Greyson, and Debbie James (2009) [J21] summarizes the results of 30 years of scientific investigation since Moody's book.

Books by Pim van Lommel (2010) [J27], by Sam Parnia [J35] (2013) [**?**]2018), and by Bruce Greyson [J5] are recent important publications.

8.1 What are NDEs?

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 NDEs summarized in the Wikipedia article [J1] seem nearly universal. These basic aspects need not occur in the order listed below.

- Out-of-body experience (OBE) characterized as detachment from the body and seeing one's own body from outside; awareness of being dead.
- Sensation of darkness, the 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 oneself or others to return back and reluctance to return.
- Suddenly finding oneself in one's own body.

This view is over-simplified.

1. NDE does not always have a positive emotional tone. About 25 % of NDEs involve negative emotions such sensations of anguish and distress.
2. Universality is not complete: the notions used to describe NDE depend on 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 [J18] (see `https://cutt.ly/ZkPdiBT`).

   However, NDE seems to always begin with OBE and end with a return to one's 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.

   The order of basic elements of NDE may be important if the goal is to build a concrete model for NDE. Neuroscientific models may well identify components of NDE that occur in a "disturbed bodily multisensory integration" but do not provide a holistic view.

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. Anecdotally, NDErs can also have a strange influence on electrical equipment.

Other effects include changes in behavior and social attitudes. 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.

8.1.3 Physiological correlates of NDE

The following is a list of 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. Experiments with rats suggest that NDE follows an intense gamma peak in EEG (around 40 Hz) 30 seconds after death (meditative states begin with a gamma peak followed by an alpha peak). The states involving NDE can last for hours. It is difficult to understand how a 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 could visual percepts 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 [I5]). Visual sensations of this kind are, howeve, simple dots or light, phosphenes: how could they integrate to form visual perceptions?

4. Meditators can produce NDEs at will and can even control them. Also psychedelics, in particular DMT produced by the body, and present in mammalian pineal gland (PG) [J29] can predictably produce NDE-like experiences. The concentration of DMT in the hippocampus of rats having heart arrest increases.

   Could the function of DMT (`https://cutt.ly/Izq2mEz`) and PG be the creation of a third person perspective (always present at cognitive level) 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 the after-life include descriptions similar to NDEs. According to the dualistic interpretations of NDE, the soul leaves the body temporarily during NDE.

Both dualistic, materialistic, and idealistic theories of consciousness can be criticized. Materialism has problem with free will. By requiring that conscious experiences correlate with the physical reality, it it is difficult to avoid the reduction of dualism to materialism [J11]. The problems of idealistic theories are mirror images of the problems of materialistic theories.

For instance, Susan Blackmore [J31, J32, J30] is materialist and an advocate of physiological explanations. She sees consciousness as an illusion. One wonders what the identification of consciousness as one particular phenomenon of consciousness really means.

According to the neuroscientific hypothesis, NDE is a subjective phenomenon due to a "disturbed bodily multisensory integration" that occurs during life-threatening events. The experience would not reflect reality but the disturbed state of the brain. What "disturbed bodily multisensory integration" means 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 could a clinically dead brain produce such complex and structured perceptions and even simulate a 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 are several philosophical guidelines.

1. A cognitive third person perspective is part of the conscious experience, yet it is not easy to understand. A sensory third person perspective is even more difficult to understand from a neuroscience perspective. It is difficult to identify a physical correlate or physiological explanation for the "third person" in the physicalistic approach.

2. Eastern philosophies based on an introspective study of conscious experience emphasize that the identification of the experiencer with the physical body is illusory. Is even the notion of an experiencer only a convenient auxiliary notion? Are experiences alone fundamental as idealists argue?

It is hard to see how NDEs could be understood within a framework of materialistic, idealistic or dualistic theories of consciousness. Something new is mandated.

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

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

1. Depersonalization model

According to this 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".

The Wikipedia article mentions the 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 about their identity; their sense of identity does not change.

2. Expectancy model

The expectancy model states that although NDEs appear very real, they are actually mental constructions in response to the stress of an encounter with death, and do not correspond to real events.

Wikipedia mentions the following objections. Subjects' accounts often differ from their own religious and personal expectations regarding death whereas imagined scenarios would rely on their cultural and personal background. The NDEs of meditators do not conform with this proposal.

3. Dissociation model

The 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 the associated suffering. 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, 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 of involved molecules, such as neural blood gas models (cerebral hypoxia, anoxia, and hypercapnia) or due to an imbalance associated with information molecules (endorphins and other neuro-

transmitters). Multifactorial models for NDE include an interplay of endorphins, neurotransmitters of the limbic system, the temporal lobe and other parts of the brain.

1. Neuroanatomical models

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

> 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, an altered sense of time, lightness vection (sensation of bodily motion) and flying..
>
> 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 the feeling of a presence, meeting and communication with spirits, seeing glowing bodies, as well as hearing voices, sounds, and music without vection..

According to French [J9]

> the temporal lobe is almost certainly involved in NDEs, given that both damage to and direct cortical stimulation of this area is 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

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

According to Parnia [J33, J34], 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.

8.4 TGD based view of biological death

This section represents a possible TGD based view of biological death. The model is of course only one particular interpretation, but is defensible by a rationale that it is based on a general vision of 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 model for biological death.

1. Upon death, breathing and heartbeat cease which leads to a loss of oxygen based metabolism. EEG signals also disappear 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 the 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 [K10, K2, K9, L70].

   This is also expected to happen in biological death. The disappearance of EEG readings could mean a shift of EEG to frequencies so low that EEG effectively disappears.

3. This would suggest that 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 $L = (h_{eff}/h)L(h)$, 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 an increasing value of h_{eff} in the hierarchy of MBs/CDs.

One can see the process possibly leading to death as an attempt of higher levels MB_n of MB to resuscitate BB by dying and in this manner providing metabolic energy to the lower level. If MB_n fails, MB_{n+1} tries. If all levels fail, death is inevitable.

1. First the level MB_{n+1} immediately above level MB_n performs BSFR (i.e. it dies in order to save MB_n). AT changes and the energy of the 3-D state initiating time reversed evolution increases since dark photons at level $n+1$ transform to those at level n (just like dark photons can transform to bio-photons giving rise to an energy release as a plant dies). Thus MB_n receives metabolic energy. NMP forces BSFR of MB_n if the negentropy gain is larger for BSFR than for SSFR, and MB_n "wakes up" as the original AT is established.

   MB_n in turn performs the same operation for MB_{n-1}. If this process manages to proceed to the level of BB, revival occurs. Breathing, heartbeat, metabolism, EEG and other basic rhythms are re-established and the person experience the return to one's own body.

2. BSFR for MB_{n+1} need not necessarily generate enough metabolic energy by time reversed dissipation to induce the revival of MB_n. In this case, MB_{n+2} tries the same. If all these attempts fail, death is inevitable.

This proposal brings to mind the story of Jesus who died to save mankind. There are also variants of the story where Jesus lived another life before resurrecting: is this time reversed life? Myths may tell us something that our present day science cannot express.

8.4.2 What could the peak in EEG gamma band mean?

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

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

1. 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 30 s after the rats' hearts stopped beating, cardiac arrest produced a transient and global surge of synchronized gamma oscillations of brain activity that exceeded the waking state.

2. High levels of global alpha-gamma coupling were also 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 [J19]. 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.

3. Could a gamma peak occur for humans? The proposal of Bokkon et al [J8] is that a 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 but it is 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 characterizing molecular transitions.

What could be the exact function of the EEG peak in the 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 a meditative state and NDE has basic aspects of the meditative state.

2. Could the gamma peak correspond to dark photons with energies of visible light? Could the gamma peak relate to the first stage of NDE involving the tunnel experience and darkness, which is also a visual experience, rather than a lack of visual consciousness, and theorized to be based on a narrowing of the visual field caused by anoxia?

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

4. Could MB utilize PG - the "third eye" - as a sensory receptor to which dark light would be transferred from MB via visual cortex. This may also provide an understanding of auditory experiences during NDE if dark photons are also the mediators of auditory information, perhaps transferred to ears.

8.4.3 Pineal gland as "third eye" in NDE?

The pineal gland (PG) - colloquially referred to as the "third eye" and the principal seat of the soul by Descartes - carries pigments like the retina in the eye and indeed serves as an eye for some animals. What about us? Could visual imagination utilize PG as an eye? Could PG take the role of the eye during NDEs during which virtual sensory input to the eyes (as in case of REM sleep) is not plausible?

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

The presence of DMT in PGs of mammalian brain is documented [J16] (`https://cutt.ly/8k5eQSS`). According to the researchers, the discovery of PG 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 PG increases.

Rick Strassman in his aptly named book "DMT: The Spirit Molecule" has studied the effects of DMT on volunteers [J29]. DMT consistently produced NDEs and mystical experiences. Many reported convincing encounters with intelligent non-human presences, aliens, angels, and spirits. Nearly all felt that the sessions were among the most profound experiences of their lives.

A curious finding is that PG becomes visible in the human fetus at 49 days, which in the Tibetan traditions (see Bardo Thodol - the Tibetan Book of the Dead) is the number of days in which a soul takes to reincarnate. These coincidences led Strassman to theorize that the soul incarnates in the body at the seventh week of pregnancy.

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

These findings compel the question: Could PG act as a third eye - and maybe also third ear - during NDE?

1. In the TGD based model for the 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 (see **Fig. 15**).

   The EEG frequencies associated with these flux tubes are inversely proportional to their length and EEG wavelengths could correspond to the flux tube lengths. Could an EEG burst also build flux tube connections for frequencies below EEG range so that communications to large layers of MB are present although not visible in EEG.

2. Various information molecules, in particular DMT which induces altered states of consciousness and is endogenous, could connect the flux tubes at the neuronal level to long flux tubes and build 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 with size scales assignable to the Earth's magnetosphere [**?**] and communicate its third person sensory input to PG as dark photons? The gamma peak suggests that DMT acts as a relay to build flux tube connections to the visual cortex which in turn has pre-existing flux tube connections to MB. Specifically how the "Spirit Molecule" connects to dark photons and flux tubes calls for further laboratory investigations.

   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 [L31]. In the case of NDEs virtual sensory input to eyes and ears is also absent in TGD unless REM dream periods and their possible auditory counterparts occur. A feedback loop between MB and PG could, in principle, make the construction of organized sensory percepts and pattern completion possible.

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

4. More generally, psychedelics could act as relays inducing these kinds of connections and psychedelic experiences and NDE indeed have some common features. This leads to ask whether the anecdotal reports given by psychedelic experiencers and involving meetings with members of advanced civilizations could be real in the sense that remote sensory experience is involved [L12, L16, L17]. Note that if these experiences are based on sending light signals reflecting back with an opposite AT (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 PG could also act as a third ear.

1. An article by Baconnier et [J13]) tells about a discovery of calcite microcrystals in PG 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 piezo-electric properties. Investigations continue to explore the bio-electromagnetic crystalline connection between PG and inner ear.

   If calcites are also present in the ear, they could transform the incoming sound signal to dark photon signals propagating to the brain and MB and also faciliate the receipt of the virtual auditory input as dark photons transformed into acoustic oscillations. Oto-acoustic sounds are sometimes heard even by an outsider. An interesting question is whether REM sleep has an analog at the level of the ears.

   In [L31] it is proposed that PG could serve as a relay station at which the dark photon radiation from MB could generate imagined visual and auditory sensations as almost-sensory experiences or send signals to the sensory organs. NDEs suggest that the sensations could already be created in PG so that in some circumstances it could act as a third ear. At the 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 induce a nerve pulse sequence as a cognitive representation of the sensory input.

2. The action of PG as a third ear could explain several strange subjective experiences, including my own. For instance, when I wake-up partially so that my body continues to sleep, I can 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 usual. Does my personal MB directly listen to my breathing and perhaps also pick up sounds from the environment - at least those created signalling the presence of living entities - and communicate the sensory data to my PG to wake me up if needed? In this way MB could act as a "guardian angel".

3. Crystals are not present only in the brain. Bones - and also PG - 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 [J25] (`http://tinyurl.com/hd3t6sr`): Posner molecules are discussed from the TGD point view in [L13] and it is proposed that the 6 phosphorus atoms could define the 6 bits of genetic codon playing a fundamental role in the dark photon communications using the GC realized as bio-harmony [L8, L9, L55, L71].

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

8.5 TGD based model for NDE

Existing data provide the groundwork for experimental tests and help to develop a more detailed picture of what happens 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 always present but not at the level of sensory input.

   The following analogy may provide a further clarity. Consider a video stream of a room to a TV monitor watched by a person. The disappearance of the video stream from the monitor serves as an analog for OBE. The video stream having the monitor screen as a blind spot would be analogous to the ordinary sensory input, and the direct visual perception of the room including TV screen would correspond to the third person sensory input.

2. EEG would be flat and would not communicate sensory data about the environment via BB to MB unless it has shifted to frequencies below EEG spectrum. MB acting as the "third person" must receive sensory information

about BB as seen from the outside. The sensory information could be communicated as dark photons emitted by the dying BB produced as Josephson radiation from cell membranes and as dark cyclotron BE condensates decay in the absence of a metabolic energy feed.

Eventually darkness enters: this does not however mean an 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 see BB anymore unless a secondary burst occurs.

3. An interesting challenge to this model are descriptions of NDEs involving memories of the conversations of the hospital personnel performing resuscitation. Could the sound waves in the environment generate the signals 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 [L55, L71] inspires the question whether dark phonons (i.e. quanta of sound) also realize GC and whether musical experiences rely on dark phonons and dark phonon triplets as basic chords coding for harmony?

8.5.2 Tunnel experience, immersion into light

Recall that a physiological explanation of the tunnel experience is as a 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 PG.

2. This does not explain the movement along the tunnel. What is moving and where it is moving? 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 (functioning as a tentacle) reaching out 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 a detailed visual view would conform with this since the infant does not cognize and cannot decompose the visual input into objects (similarly, if congenitally blind people get vision back, they see only diffuse light).

2. Note that if the child entangles with mother negentropically, he/she could share its mother's sensory mental images to perceive and perhaps even interpret the world. The experience of unconditional love and peace during this period of NDE could correspond to a memory about maximum entanglement with the mother before the moment of birth. NEDrs also report meeting 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 also possible immediately after birth?

3. Memories would be represented essentially as 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 dark photons with positive energy located in MB and form a representation of memories.

8.5.3 Life review and the decision to return

Life review at death is both an abstraction and a summary. Life review consists of experiences of the reincarnate R during NDE, when the entire brain could be dead. The survivor S remembers them. How can one understand this?

1. Sleep is "small death" and corresponds at some level of MB to a conscious state with non-standard AT. Life review is analogous to remembering conscious experiences during the sleep state. We remember from the sleeping period only our dreams.

   The TGD proposal is that MB for some part of the brain (say the visual cortex) is awake during dreams. This makes communication of memory mental images possible since the signals have the AT of the awake person.

2. Could this also be true for memories in the life review experience associated with NDE. Could the dead brain have regions whose MBs are awake and make possible the communication of life review? Could the MB of PG, which would act as a guardian angel and soul, be the higher level self which communicates the life review?

What does the decision to return to life mean? Return could mean a second BSFR re-establishing the original AT leading to a revival. NMP forces BSFR [L74] so that the effective decision maker would be an abstract principle rather than a 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 PB. Also the actual memories located in the half-cone representing the active half of CD are changed.

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

1. The sensitivity to light at some wavelengths should relate to dark photons having an energy spectrum in the visible and UV range. 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 educated guess here is that the connections to some parts of MB (with cyclotron frequencies to certain wavelengths) are strengthened in NDE.

2. The emission of this light changing partially to ordinary photons (biophotons) might also cause effects on electronics. The electronvolt is the natural energy unit for charged particles accelerating along flux tubes in electronic systems. Therefore these dark photons could have effects on MB of electronic systems. Could the poorly understood $1/f$ noise in electronic systems 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 behave like 1/length in accordance with fractality.

9 Conclusions

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

1. The TGD inspired theory of consciousness relies on adelic physics [**?**, L22], which fuses the physics of sensory experience, based on reals, with the physics of cognition based on p-adic number fields. Entanglement negentropy is always non-positive in ordinary physics but in adelic physics it contains an additional cognitive contribution and can be positive for EQs.

   NMP is the basic variational principle of consciousness generalizing SL and implying 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 sub-atomic to astrophysical scales, by identifying signatures of time reversal. For an observer with standard AT, dissipation with a reversed AT manifests as thermo-dynamic anomalies conflicting SL. Generation of gradients and structures, SO and also SOQC giving rise to homeostasis are the basic signatures.

3. The biological applications include models of quantum biology and of a quantum brain relying on the notion of MB and $h_{eff} = n \times h_0$ hierarchy defining a master-slave hierarchy.

   The basic prediction is the quantum coherence of layers of MB with arbitrarily long size scales. MB induces the coherence of ordinary biomatter at the bottom of the hierarchy.

   This vision inspires a model of aging and biological death. Aging would be due to the approach of MB to a thermal equilibrium with BB. The temperature of MB increases and approaches the Hagedorn temperature [B1] of flux tubes which would be near physiological temperatures. By its large heat capacity,

MB could also serve as a metabolic energy storage unit. For instance, MBs of stress proteins would serve this function [L77].

4. The TGD based model of the brain differs from the 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 makes possible the identification of sensory organs as seats of fundamental qualia - also basal ganglia inside the brain could also play this role. In particular, PG could serve as a sensory organ during NDEs.

5. A model for what happens in biological death is developed using NDEs as input. The proposal is 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 temporary death at level " n" gives to the possibility of rebirth as a second BSFR at level " n" . If not, the level "$n+1$" tries the same. An analogy with the Christian resurrection story is one comparative example. The model explains the basic aspects of NDE such as OBE experience, tunnel experiences and immersion into light, meeting light beings dead beloved ones, life review, and a decision to return. OBE would correspond to a third person sensory perspective with MB in the role of perceiver. The sensory input could be sent by MB to the brain and amplified at PG taking the role of eyes and ears as a central sensory receptor.

10 Appendix

10.1 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 an 8-D space $M^4 \times CP_2$ obtained from empty Minkowski space (M^4) by adding four small dimensions (CP_2). 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. 4**) consists of space-time sheets with various length scales with smaller sheets being glued to larger ones by ***wormhole contacts*** (see **Fig. ??**) identified as the building bricks of elementary particles. The sizes of wormhole contacts vary but are at least of 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 is implied, and biology is especially interesting in this respect.

- ***Topological field quantization (TFQ)*** . TFQ replaces classical fields with space-time quanta. For instance, magnetic fields decompose into space-time surfaces of finite size representing flux tubes or -sheets. Field configurations are like Bohr orbits carrying "archetypal" classical 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 (e.g. 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 - e.g. in the case of the flux tube connecting two systems).

  Maxwellian electrodynamics cannot have 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 makes it possible to define the QFT limit of TGD.

- ***p-Adic physics*** [K14] as a physics of cognition and intention and the fusion of p-adic physics with real number based physics are new elements.

- ***Adelic physics*** [L22, L23] 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.

- A ***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 which is crucial in living matter.

- ***MB as an intentional agent using biological body (BB) as a sensory receptor and motor instrument*** . The personal MB associated with the living body - as opposed to larger MBs assignable with collective levels of consciousness - 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 (analogous to body parts of BB), 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, thus changing the value of the magnetic field, and in turn 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 the molecular level bring a new element to biochemistry making it possible to understand bio-catalysis. Flux tube connections serve as a space-time correlates for attention in the TGD inspired theory of consciousness.

- ***Cyclotron Bose-Einstein condensates (BECs)*** 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 at MBs of basic biomolecules and of cell membrane proteins - play a key role in TGD based biology.

- ***Josephson junctions*** exist between two superconductors. In TGD framework, ***generalized Josephson junctions*** accompany membrane proteins such as ion channels and pumps. A voltage between the two superconductors implies a ***Josephson current***. For a constant voltage the current is oscillating with the ***Josephson frequency*** . The Josephson current emits ***Josephson radiation***. The energies come as multiples 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 BEC at MB receives the radiation producing a sequence of resonance peaks.

- ***Negentropy Maximization Principle*** (NMP). NMP [K6] [L74] 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, the 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 a physical event in the ordinary ontology. Positive and negative energy parts of the zero energy state are at the opposite boundaries of a ***causal diamond*** (CD, see **Fig. 11**)) 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 determined by the space-time sheets in the imbedding space region spanned by CD.

10.2 Appendix B: Figures

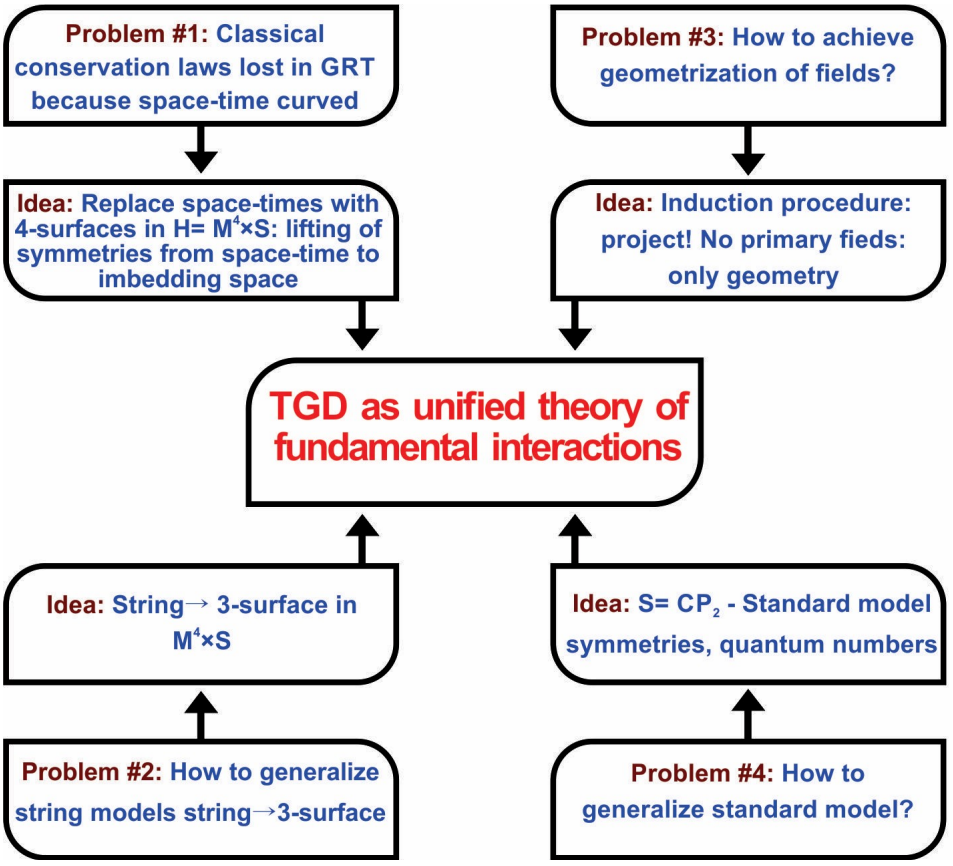

Figure 1: The problems leading to TGD as their solution.

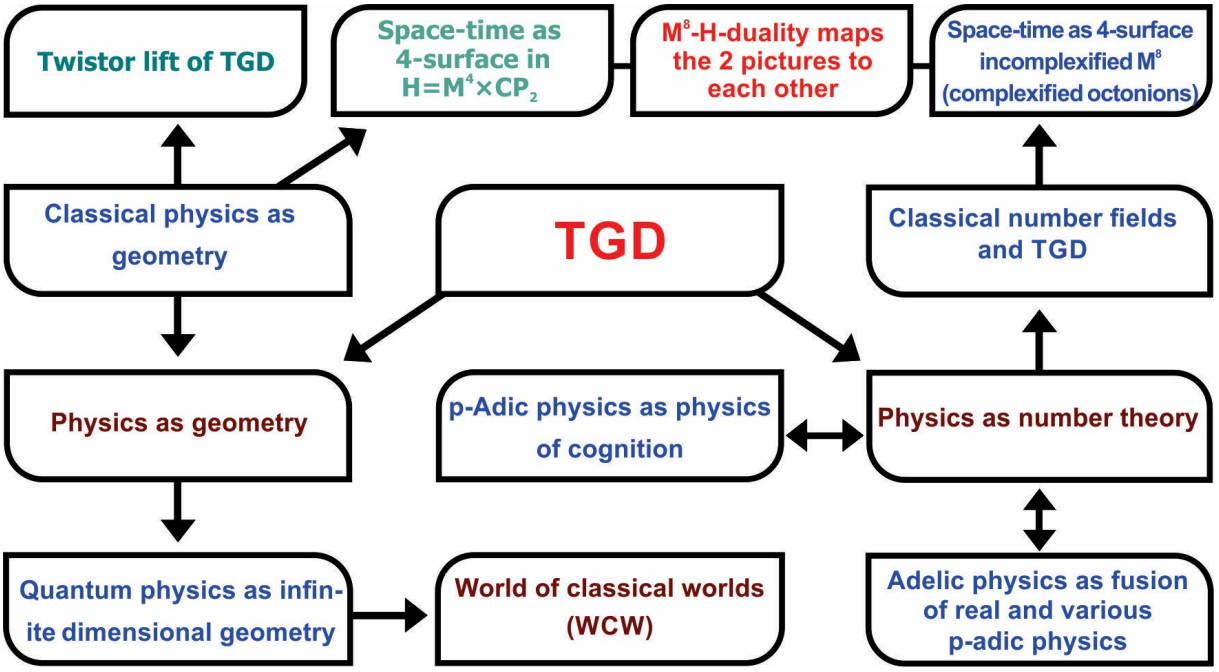

Figure 2: TGD is based on two complementary visions: physics as geometry and physics as number theory.

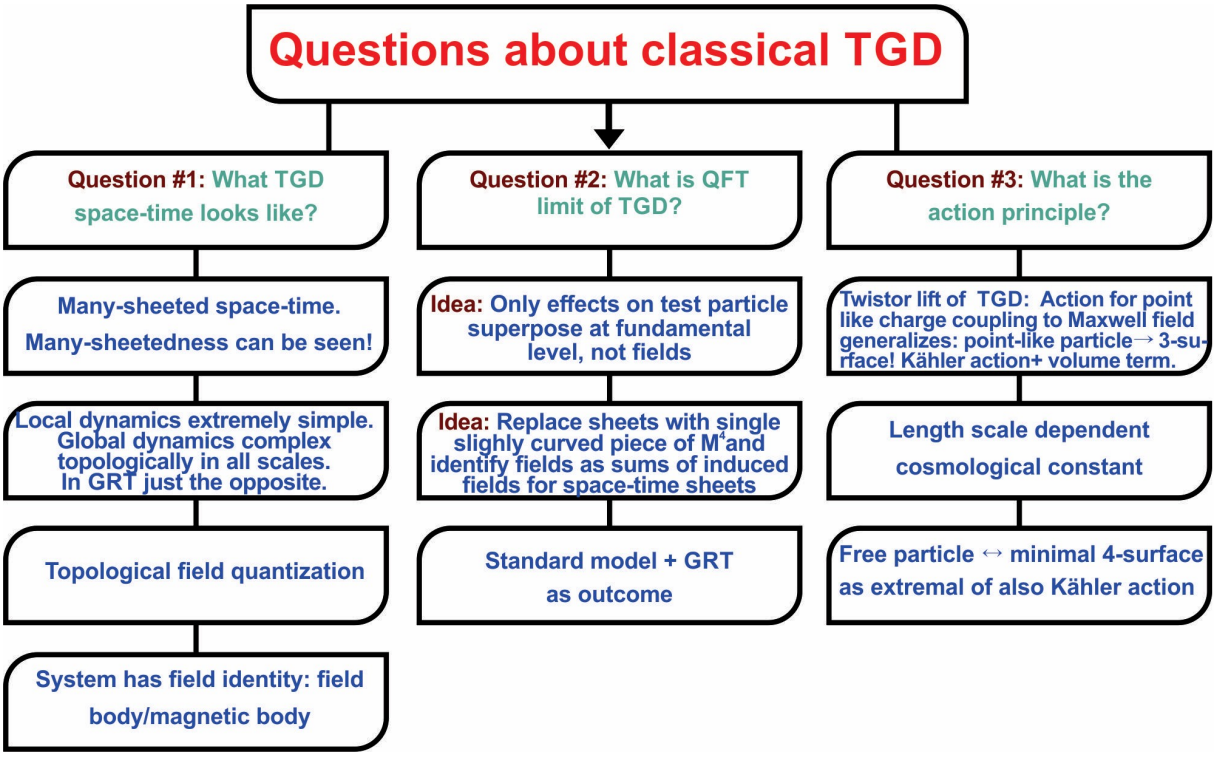

Figure 3: Questions about classical TGD.

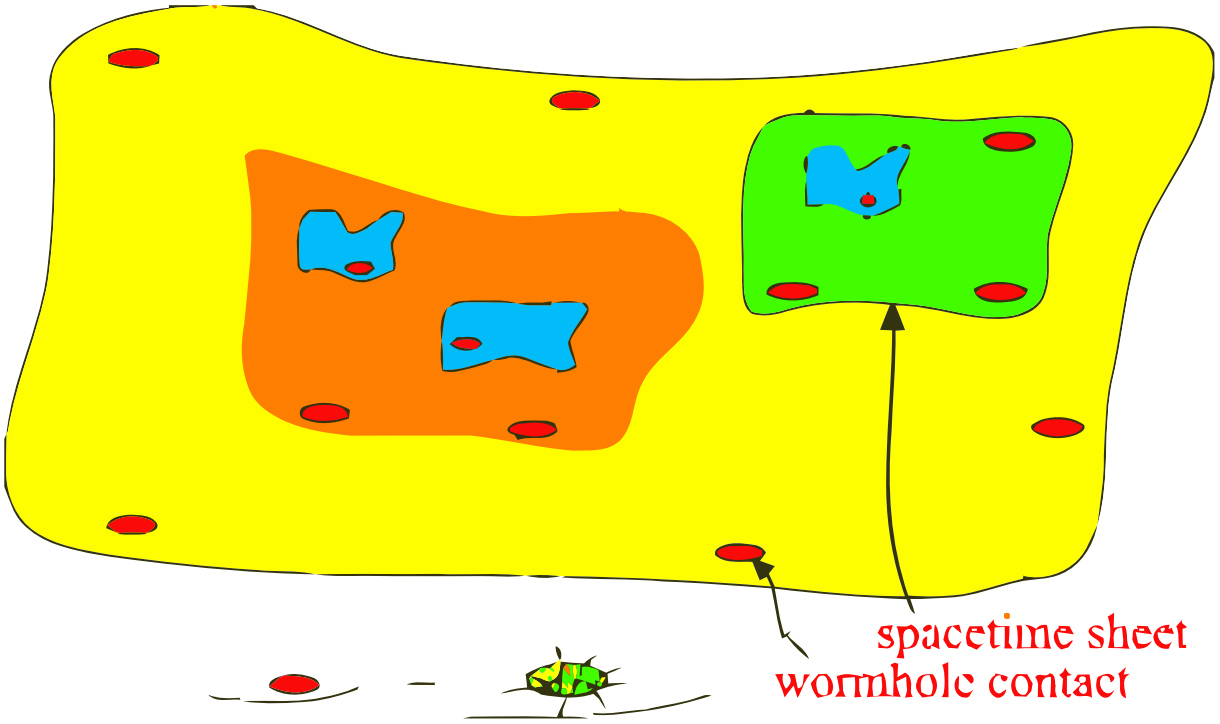

Figure 4: Many-sheeted space-time

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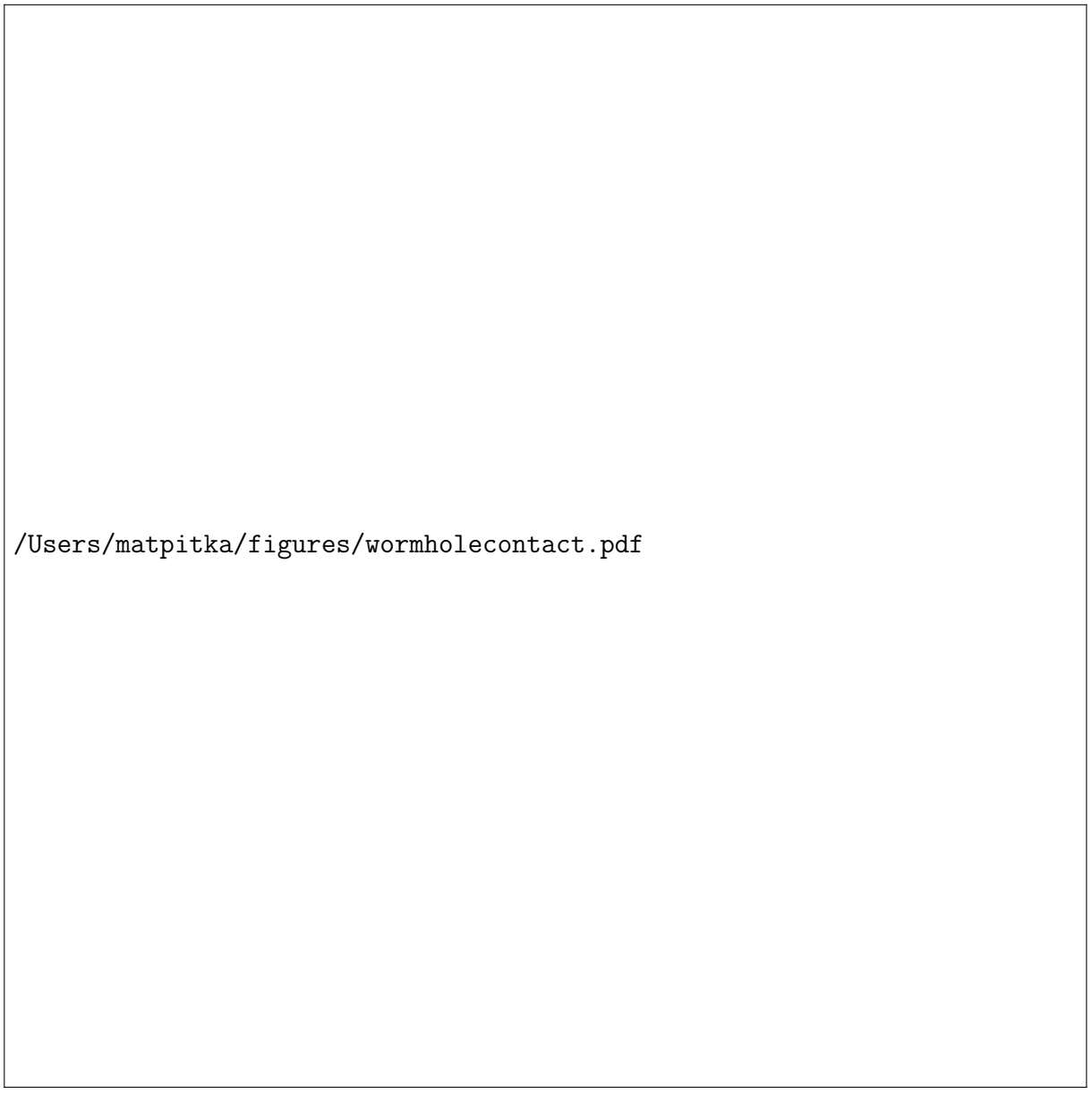

Figure 5: Wormhole contact.

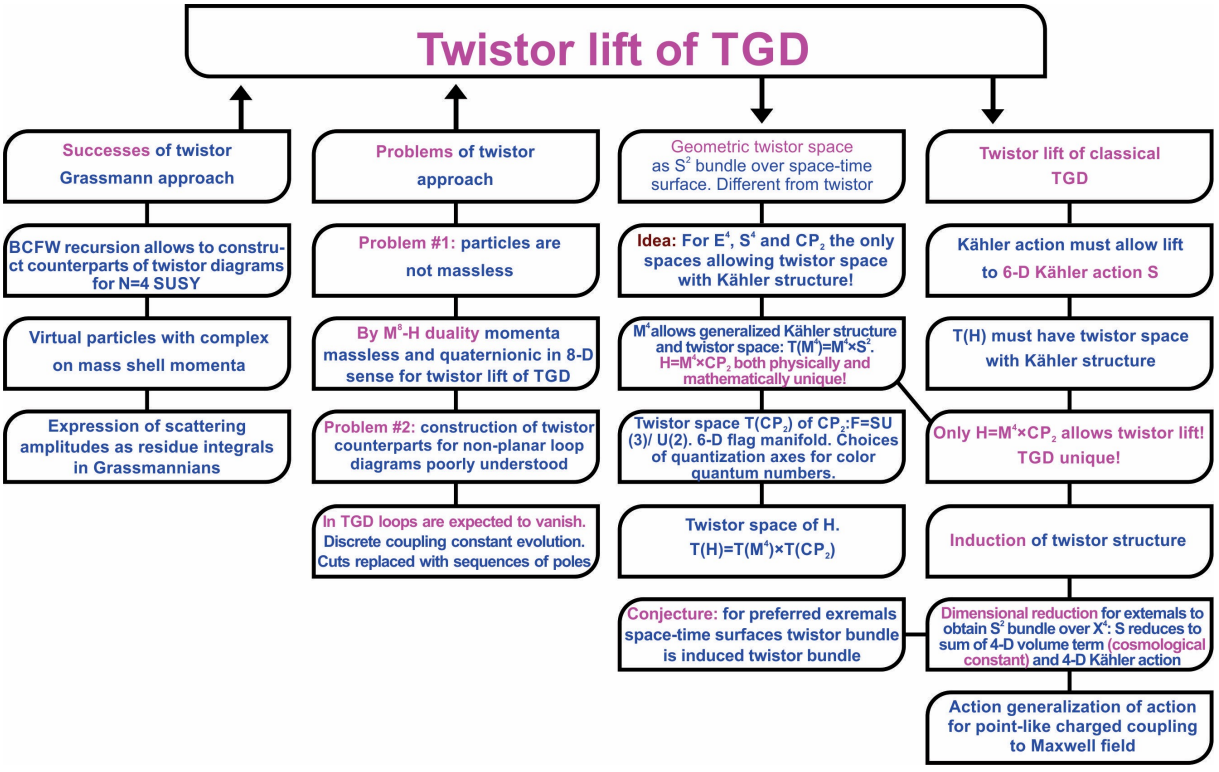

Figure 6: Twistor lift

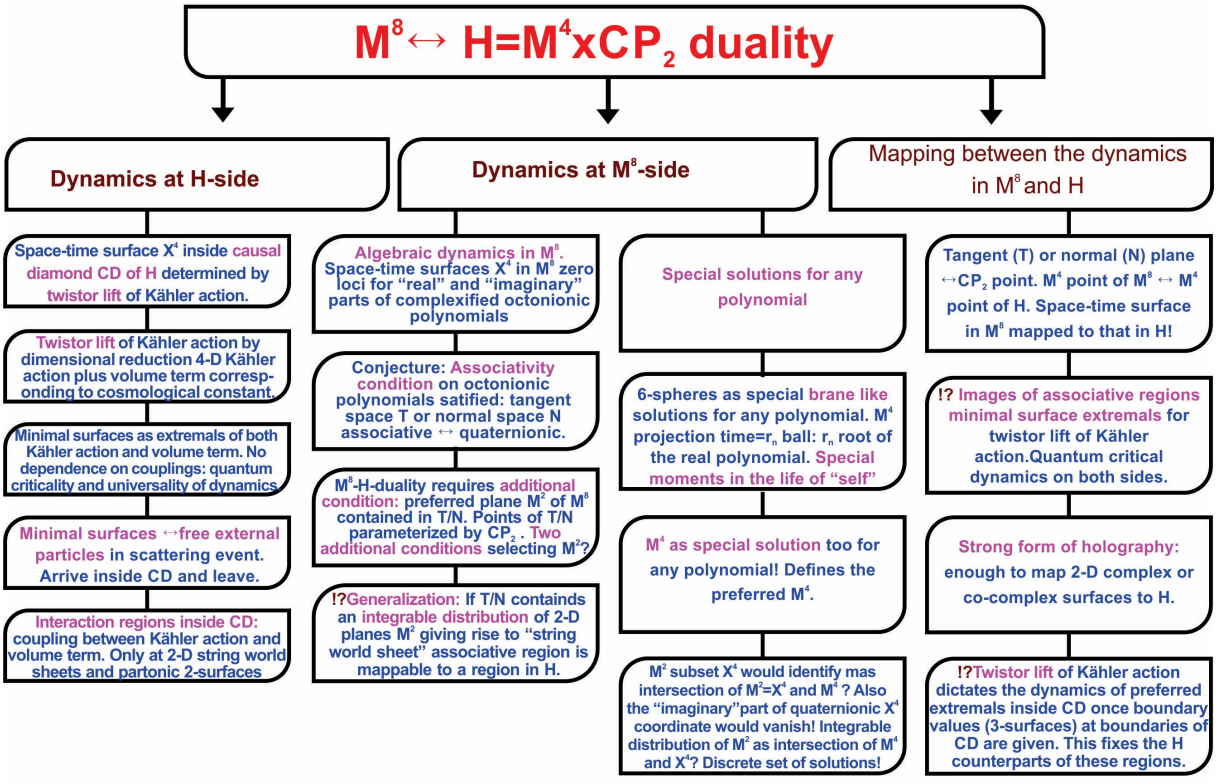

Figure 7: $M^8 - H$ duality

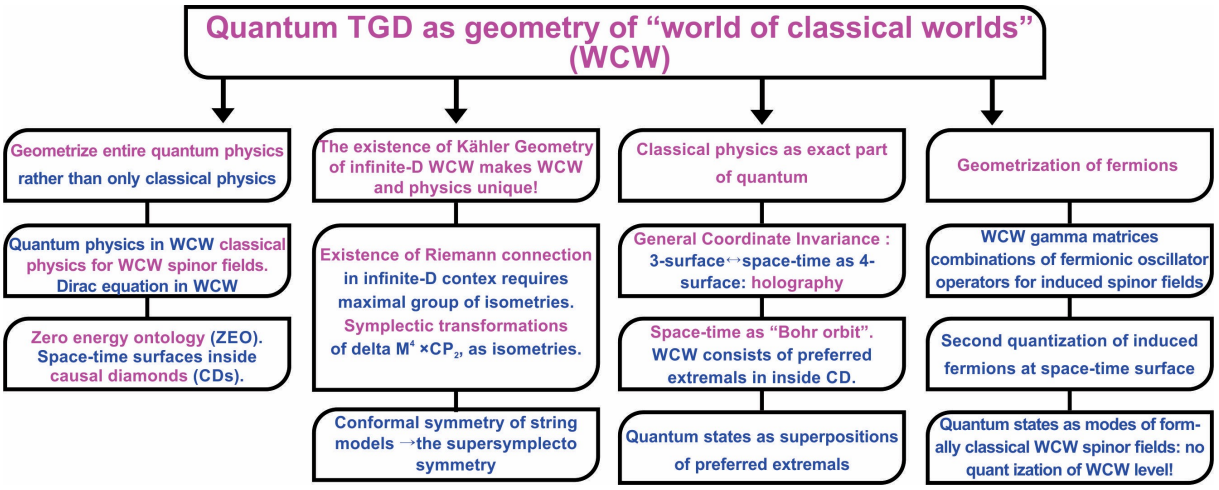

Figure 8: Geometrization of quantum physics in terms of WCW

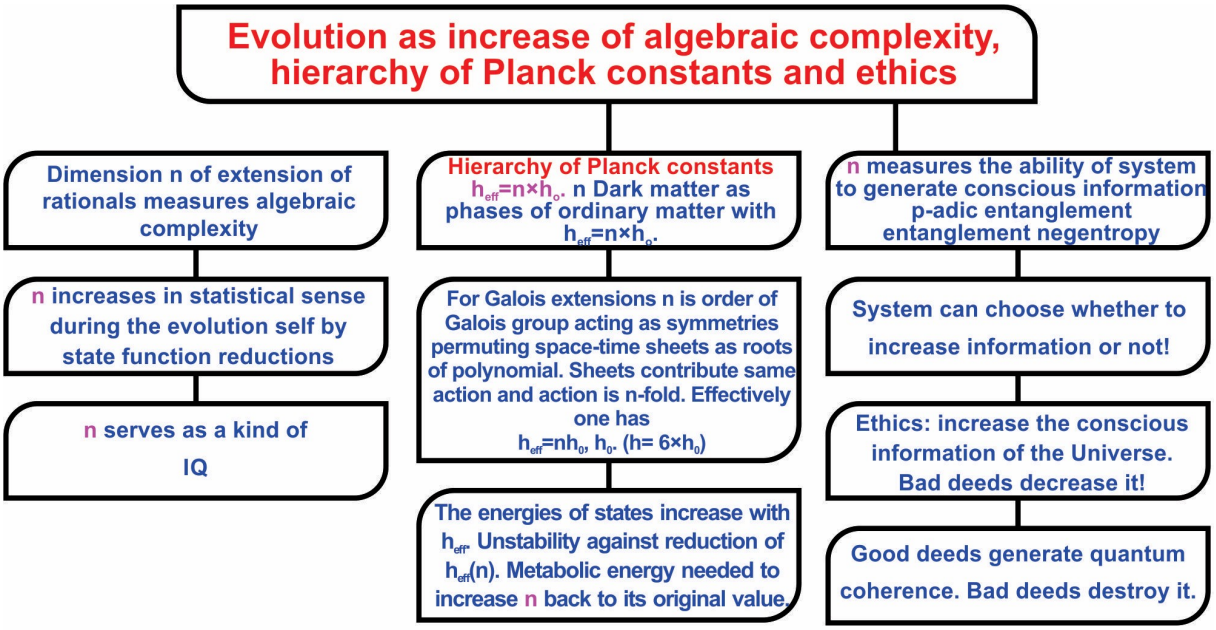

Figure 9: Number theoretic view of evolution

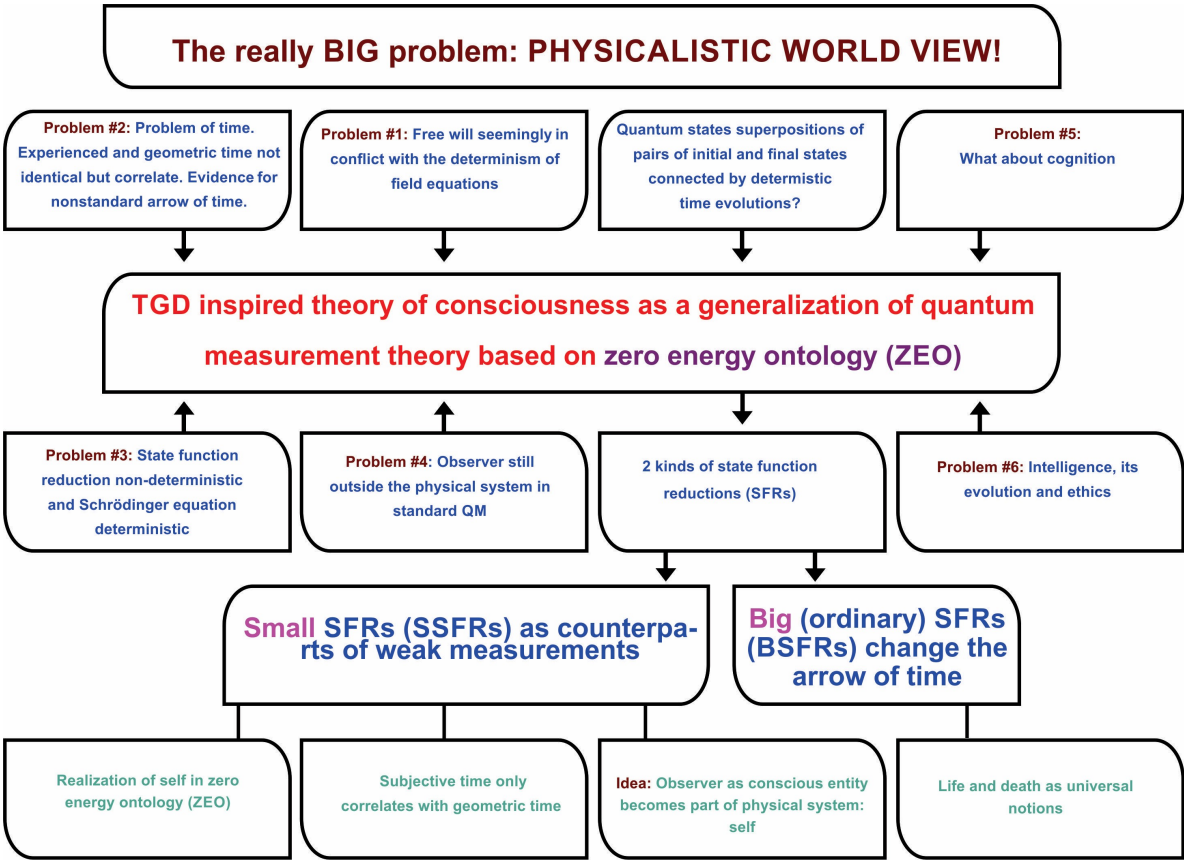

Figure 10: Consciousness theory from quantum measurement theory

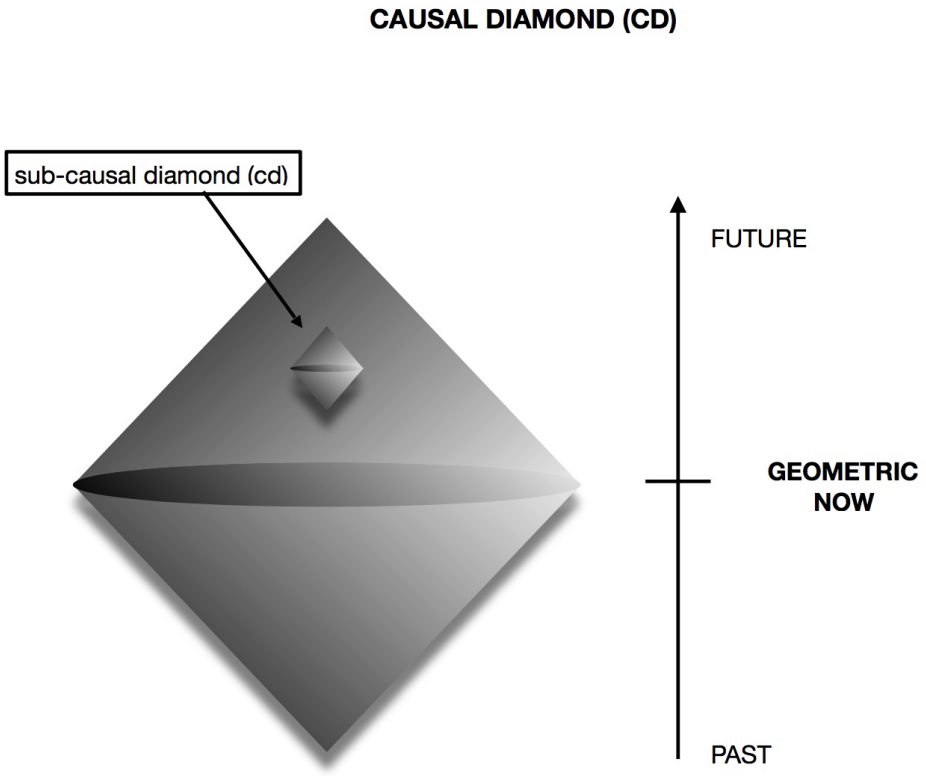

Figure 11: Causal diamond

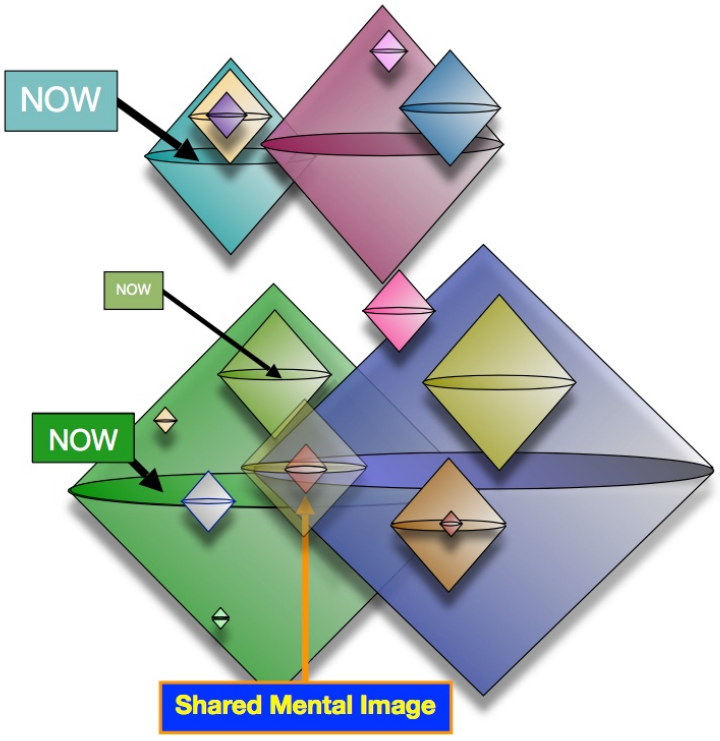

Figure 12: CDs define a fractal "conscious atlas"

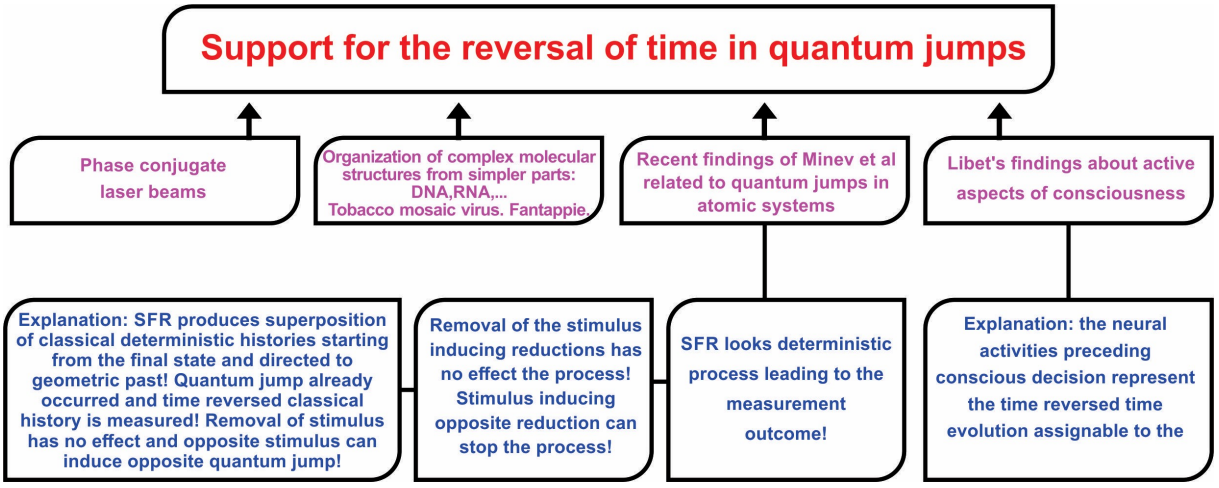

Figure 13: Time reversal occurs in BSFR

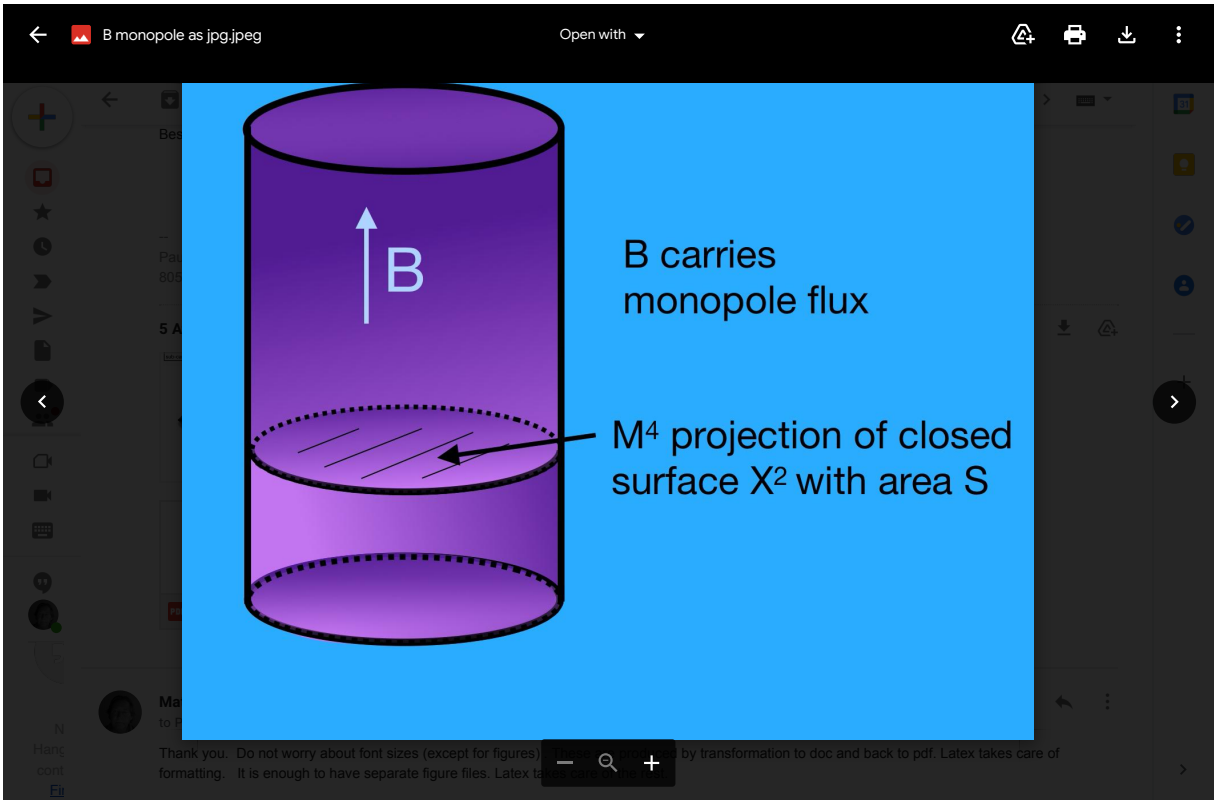

Figure 14: The M^4 projection of a closed surface X^2 with area S defining the cross section for monopole flux tube. Flux quantization $e\oint B \cdot dS = eBS = kh$ at single sheet of n-sheeted flux tube gives for cyclotron frequency $f_c = ZeB/2\pi m = khZ/2\pi mS$. The variation of S implies frequency modulation.

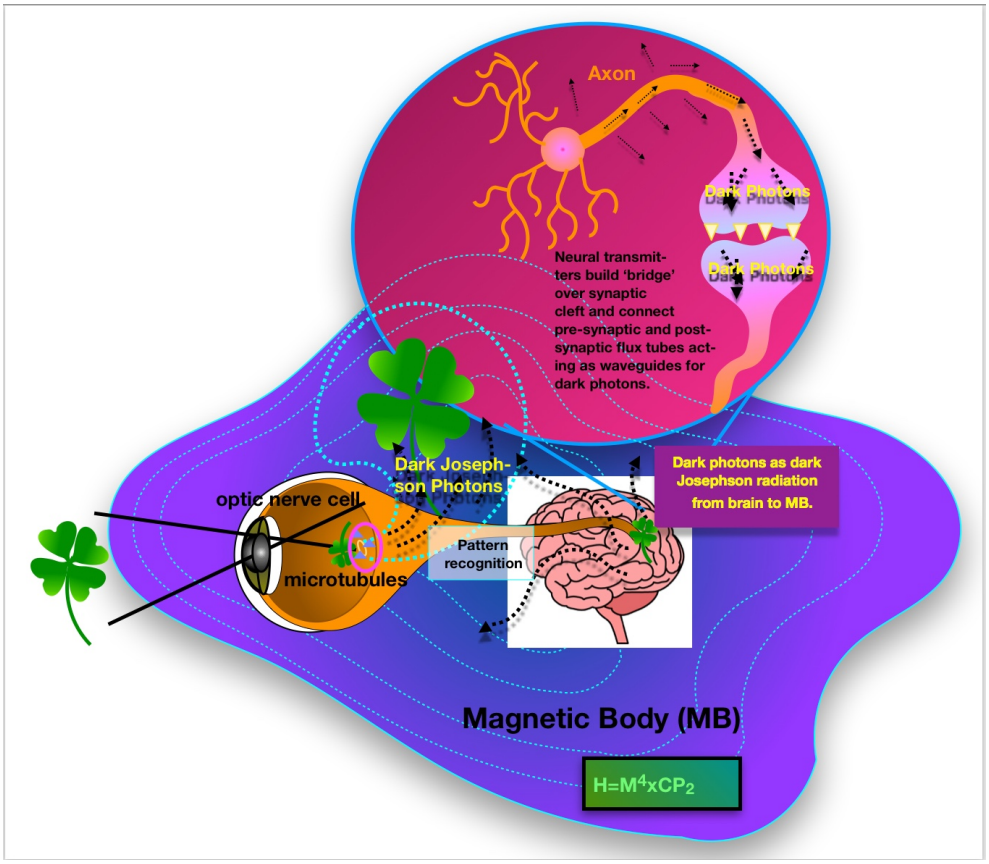

Figure 15: Dark Josephson photons communicate sensory data to the "big" part of MB. Also the back and forth communications between sensory organ and brain use dark photons.

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