Answers to the questions of Vasileios Basios and Marko Manninen in Hypothesis Refinery session of Galileo Commission

February 1, 2026

M. Pitkänen[1], V. Basios[2] and M. Manninen[3]

[1] Independent researcher. Email: matpitka6@gmail.com.
http://tgdtheory.fi/.
Postal address: Valtatie 8 as 2, 03600, Karkkila, Finland.

[2] Email: vbasios@gmail.com.

[3] Email: elomedia@gmail.com.

Abstract

Galilei Commission is a Scientific and Medical network with the goal to help the transition from the materialism and reductionism dominated view of science to a post-materialistic world view expanding the science so that also consciousness, life and spirituality are accepted as aspects of reality.

There are of course very many proposals for what a post-materialistic view might be and TGD (Topological GeometroDynamics) and TGD inspired view of consciousness and quantum biology is one of these views. In this view theory of conscious experience can be seen as a generalization of quantum measurement theory based on new quantum ontology forced by TGD.

I participated in a Hypothesis Refinery meeting Galilei Commission held 27.1. 2026 and talked about TGD inspired theory of consciousness. There were very interesting questions by Vasileios Basios and Marko Manninen that I received already before meeting. Unfortunately, the time allowed me to answer only some of these questions during the meeting. Therefore I decided to write an article containing the somewhat shortened questions and my responses. As always, this process stimulated fresh observations.

1 Introduction

Galilei Commission (see this) is a Scientific and Medical network with the goal to help the transition from the materialism and reductionism dominated view of science to a postmaterialistic world view expanding the science so that also consciousness, life and spirituality are accepted as aspects of the reality.

There are of course very many proposals for what a post-materialistic view might be and TGD (Topological GeometroDynamics) and TGD inspired view of consciousness and quantum biology is one of these views. In this view theory of conscious experience can be seen as a generalization of quantum measurement theory based on new quantum ontology forced by TGD.

I participated in a Hypothesis Refinery meeting Galilei Commission held 27.1. 2026 and talked about TGD inspired theory of consciousness [L22]. There were very interesting questions by Vasileios Basios and Marko Manninen that I received already before meeting. Unfortunately, the time allowed me to answer only some of these questions during the meeting. Therefore I decided to write an article containing the somewhat shortened questions and my responses. As always, this process stimulated fresh observations.

For instance, I formulated more precisely the crucial arguments behind the holography = holomorphy hypothesis implying also the universality implying that the solution ansatz makes sense for any general coordinate invariant action constructible in terms of the induced geometry.

I discussed in detail the classical non-determinism crucial for cognition already present for 2-D minimal surfaces (soap films). Since classical non-determinism is so crucial, I added an appendix about what it means geometrically in the 2-D case and how it might generalize to the 4-D situation.

I also clarified the testable implications of the h_{eff} hypothesis in biology derivable from the explicit expressions for gravitational and electric Planck constants.

2 Comments inspired by the critical questions by Vasileios Basios

I hope that these hastily written comments could serve as answers to your questions, at least to some degree!

2.1 Q1: Is operational distinction between BSFR-induced time reversal and thermodynamic time reversal possible

BSFR induced time reversal occurs at quantum level and induces thermodynamic time reversal in shorter scales. Time reversal is not possible in standard thermodynamics so that the question is not quite clear to me.

A natural assumption is that the magnetic/field body as a controller induces an effective change of the arrow of time at shorter scales. The general signature of BSFR is dissipation in a "wrong" time direction. Diffusion and heat transfer occur in the wrong direction.

In the following I will consider BSFRs in more detail.

2.1.1 Some examples of BSFRs

1. One half of the universe should have a reversed arrow of time! Magnetic ghosts with large h_{eff} would be everywhere!
2. The negatively charged EZs appearing in Pollack effect clean themselves: diffusion with reversed arrow of time. Also energy can be apparently extracted from the environment rather than fed from it.
3. Phase conjugate laser rays dissipate in opposite time direction [D1].
4. Libet's findings can be understood in terms of BSFR. The crucial question is whether the neural activity preceiding volitional acts occurs with an opposite arrow of time.
5. Fingelkurts brothers [L1] found that EEG period divides into two halves. Organized and chaotic: life and death.
6. Sleep as "small death". That there are no memories from the period of deep sleep is explained by the fact that classical signals from that period travel to the "wrong" time direction and do not reach the person after wake-up.
7. Homeostasis serves as a basic example in biology. The system is at the top of the hill and falling down all the time and making a time reversal to return back. The models based on computationalism require a complex hierarchical software involving control of control of ... in order to achieve this. In the TGD Universe it occurs automatically.
8. BSFRs as a universal mechanism behind conscious intelligence. Trial and error process by returning back in time and starting again. Problems are solved by dying for a moment. During sleep problems are indeed solved.

9. Earth's geological and biological evolution between creation of the Moon as an explosion throwing out a surface layer of the Earth and Cambrian Explosion (CE) [L23]. Sudden emergence of highly evolved multcellular life in CE from underground oceans as the radius expanded by factor 2.

2.1.2 Does BSFR induced self-organization-like process differ from ordinary thermodynamic self-organization?

Single BSFR induces time reversed dissipation, which as such does not correspond to self-organization although the dissipation can look as a self-organization when looked in the opposite time direction. Pairs of BSFRs induce observable effects in a given time direction and lead to self-organization since in SFRs the algebraic complexity is bound to increase in statistical sense.

Is it possible to distinguish BSFR induced self-organization-like processes as pairs of BSFRs (having interpretation as quantum tunnelling) from the ordinary thermodynamic self-organization involving thermodynamic phase transitions and thermodynamic criticality?

1. Feed of energy necessary in both cases. Induces ordinary self-organization in TGD at quantum criticality and the increase of complexity. h_{eff} increases.

   Cautious question: Could thermodynamic self-organization reduce to quantum self-organization?

2. The time reversed second law. Fantappie introduced the notion of syntropy as entropy with a reversed arrow of time [J6]. To my view, the apparent reduction of entropy for BSFR does not however correspond to self-organization. Pairs of BSFRs correspond to self-organization.

   Is it possible to understand this in terms of standard thermodynamics?

2.1.3 How to kill the BSFR hypothesis?

One can find evidence for BSFR but killing BSFR is not easy. BSFR makes sense only if systems with long range quantum coherence are possible. One could try the following.

1. Show that various biological effects explained by BSFR (such as SOC and homeostasis) can be explained without BSFRs. Computationalism would require development of hierarchical software: control of control of .... How the Universe obeying second law could achieve this? In TGD this is unavoidable.

2. Explain the phenomenon of sleep without BSFR.

3. Demonstrate that in Libet's experiments the neural activity corresponds to an ordinary arrow of time.

2.2 Q2. Holography = holomorphy hypothesis and qualitative character of consciousness

2.2.1 How qualia, felt qualities of experiences are produced

1. Holography = holomorphy hypothesis implies weak classical non-determinism (no failure of classical field equations). This non-determinism occurs already for 2-D minimal surfaces and space-time surfaces are predicted to be minimal surfaces.

   Conscious experience in SSFRs made possible by the classical non-determinism: entangled between two different quantum states (conscious-NESS refers to materialism and is a misleading term in TGD).

2. Reduction of entanglement between systems A and B in SSFRs. A corresponds to non-deterministic cognitive degrees of freedom of self. B could correspond to cognitive or ordinary degrees of freedom associated with A itself or B. There are several alternatives. Exotic modes of consciousness would correspond to different kinds of entanglements (cognitive-ordinary, cognitive-cognitive for system A for pair A-B).

3. Always a quantum measurement would be in question. Qualia are labelled by the values of observables assignable with the periods between 2 subsequent SSFRs. The first SSFR defines the context. Map from pairs of SSFRs→qualia. It is not possible to give formula for a quale.

4. Two kinds of values for observables.

   (a) Discrete quantum numbers. Could sensory qualia correspond to standard model quantum numbers? Color qualia as color quantum numbers for quarks with large h_{eff}. Findings of Barbara Shipman support this view [L4].

   There are also Galois quantum numbers and they could relate to cognition, in particular SSFR cascades associated with hierarchical downwards directed cognitive entanglement made possible by inclusion hierarchy of Galois subgroups associated with extensions of extensions... of rationals describable in terms of functional composition for the solutions of field equations.

   (b) Geometric qualia corresponding to measurements analogous to position measurements in WCW inducing a localization. The moduli of CDs are parametrized by a finite-D symmetry group. Poincare transformations, scalings, conformal transformations of M^4. Geometric time as the distance between the tips of a CD. Hierarchy of CDs gives rise to hierarchies of mental images.

   Also the selections of quantization axes define geometric qualia. The twistor spaces for M^4 and CP_2 (only these allow twistor spaces with Kähler structure and this also fixes TGD) define qualia. Barbara Shipman [A1] [L4] noticed that CP_2 twistor space $SU(3)/U(1) \times U(1)$ pops up in her model for honeybee dance.

2.2.2 Can one understand the unity of consciousness

1. In idealistic approach the problem is to understand why separate conscious entities seem to exist. It is hard to understand this as an illusion. In TGD the situation is different.

2. When entanglement is generated, unity of consciousness increases. When measurement occurs, entanglement is reduced and two separate systems emerge (Krishnamurti has talked about this a lot). Conscious entities are fusing and splitting all the time: analogy with particle reactions and chemistry.

3. Irreducible cognitive states cannot split by de-entanglement to a pair of systems. The Galois group has a hierarchy of subgroups and allows hierarchical entanglement having interpretation in terms of downwards directed attention. Simple Galois groups do not allow this and could correspond to cognitive consciousness without content or to basic bricks of cognition. The end of thinking.

4. Cognitive abstraction hierarchies defined by space-time surfaces. Take space-time surface $f = (f_1, f_2) = (0, 0)$. Form functional composites $g \circ f$ using maps $(g_1, g_2) : C^2 \to C^2$ mapping (0,0) to (0,0). $(f_1, f_2) = (0, 0)$ is still the solution of $g \circ f$. Infinite abstraction hierarchies with increasing size of Galois groups and complexity. What if f f does not allow composition $f = g \circ h$. Is this pure or primary consciousness? Archetypes of Jung?

2.3 Q3a Magnetic body and h_{eff} hierarchy

The findings of Blackman et al [J2] gave empirical motivations for h_{eff}.

1. Number theoretic interpretation is not completely fixed. Is h_{eff} as dimension of extension and of Galois group or degree of polynomial? For Galois groups, which are simple, h_{eff} would be a prime. Primes polynomials have prime degree. Spectrum of h_{eff} a measure for the evolutionary level of the organism.

2. Large h_{eff} phases are created at quantum criticality because long length scale fluctuations are involved.

   (a) Self-organized criticality (SOC) [J3] is poorly understood in standard physics. Could quantum criticality explain SOC?

(b) Interactions between long and short scales typical in biology. EEG frequencies are extremely small. Large h_{eff} makes dark photon energies large so that interaction with shorter length scales is possible. Dark low frequency photon transforms to ordinary high frequency photon of a bunch of photons with the same frequency.

3. Energies grow with h_{eff} and it tends to be spontaneously reduced: reverse Pollack effect. Pollack effect induces transitions -OH $\rightarrow$ O^- + dark proton (-OH is hydroxide group) [L13, L19]. Metabolic energy transfer keeps the distribution of h_{eff} values as such.

   Not only photons do induce the Pollack effect. For instance, formation of molecules liberating energy could kick ions to monopole flux tubes.

4. Pollack effect would be in a central role at the ATP level. Inorganic phosphate P_i transforms to organic phosphate ion P as a proton with large h_{eff} is formed. The transformation ADP$\rightarrow$ATP $\rightarrow$ to acceptor takes place and. ATP$\rightarrow$ADP involves transfer of P to the acceptor and the dropping of the dark proton implies energy transfer to the acceptor.

5. Dark nuclei reside at monopole flux tubes: nuclear binding energy is much smaller than for ordinary nuclei but stabilizes the dark phase. This would occur in the case of DNA, cell,...,Earth.

   "Cold fusion" provides empirical evidence [L17]. Provides a short circuit to nuclear fusion at room temperature. Decay of dark nuclei to ordinary nuclei liberates practically all nuclear binding energy. Could be a basic process even in supernovas and at the surface of stars, outside stars, and even in nuclear collisions.

6. One intriguing piece of evidence for p-adic physics in biology. The p-adic length scales associated with (Gaussian) Mersenne primes $MG, k = (1+i)^k - 1$: $M_{G,151}$, $M_{G,157}$, $M_{G,163}$, $M_{G,167}$. These Mersennes define four miracle primes defining biologically important scales in the range 10 nm (thickness of the neural membrane),...,2.5 μm (size of the cell nucleus), which could be highly relevant for the DNA structure.

How to test this vision?

1. Disappearance of protons or ions as a signature for the ordinary to dark transformation. Conservation laws are apparently broken. This is possible also for electrons and there is evidence for this. Electrons are found to mysteriously disappear in rare earth metals when thermal energy is feeded. Systematic experiments with radiation with energy with precise transition energy could make easy to demonstrate the effect.

2. Pollack effect and its generalizations could have a central role in testing.

3. Testing at the level of subjective experience is possible for living matter. h_{eff} distribution flattens $\rightarrow$ system's IQ decreases, it gets tired and can even lose consciousness.

4. Predicted cyclotron transitions could serve as test. The experiments of Blackman and others could serve as a starting point. Cyclotron frequencies of biologically important ions. Bosonic ions like Ca and Mg forming BE condensates. Universal spectrum of cyclotron energies for gravitational Planck constant h_{gr} [E1] is predicted: no dependence on the mass of the ion.

5. Stability of the h_{eff} phases is achieved in some cases by the formation of dark nuclei at the magnetic body: DNA, nucleus, cell, neuron, trigeminal nerve, Earth are stable negatively charged systems suggesting that dark protons for dark nuclei at the magnetic body.

Gravitational and electric Planck constants are in a special role. As a matter of fact, it is not clear whether there are other kinds of effective Planck constants. There are two especially important cases: h_{gr} and h_{em} assignable to classical gravitational and electric fields.

1. For h_{gr}, the gravitational Compton length does not depend on particle mass and depends only on the solar mass or Earth mass, being 1/2 of Schwartschild radius $r_S = 2GM$. This reflects Equivalence Principle .5 cm for Earth, snowflake size for $v_0/c \simeq 1$. For Sun $v_0/c \simeq 2^{-11}$. $v_0/c = 1/n$, quantized. There are also corresponding universal frequencies.

These predictions are very strong and could be killer predictions. The snowflake would have a roughly 1/10 times smaller in size on Mars!

2. h_{em} is proportional to a product Qq of charges must be so large that $Qq\alpha$ is larger than 1. For $q = 1$, Q must be large enough.

   For DNA it is proportional to the length of DNA strand and for cells it is proportional to the surface area of the cell membrane. For large neurons, in particular pyramidal neurons and the trigeminal nerve it is very large and would correspond to the highest IQ. For DNA strand pairs Q^2 is very large!

3. Ionic cyclotron transitions in the magnetic field of monopole flux tubes about $B_{end} = 2B_E/5 \simeq .2$ Gauss as a test [J2].

2.4 Q3b: Model for the genetic code as icosa tetrahedral tessellation of H^3

1. Hyperbolic 3-space is realized in particle physics as mass shell. It also corresponds to a light-cone proper time constant hyperboloids. There is huge number of hyperbolic tessellations as analogs of Euclidian lattices. Icosa tetrahedral tessellation of H^3 completely unique [L9].

2. Hyperbolic model for the genetic code emerged from a model for music harmony [L2, **?**]. Hamiltonian cycles for icosahedra are closed paths through all 12 vertices. Each Hamilton cycle defines a 12-note scale and triangles define 3-chords of a 20-chord harmony. Tetrahedron gives 4 chords. 3 different types of icosahedral harmonies and 3 different types of icosahedral harmonies plus single tetrahedral harmony defines bioharmony with 64 chords/triangles.

   Aminoacids correspond to orbits of the triangles under the symmetries of the Hamiltonian cycle: Z_6, Z_4 or Z_2. The numbers of the codons coding for a given amino-acid are predicted almost exactly.

3. Physical representation of codons as dark proton triplets at the vertices of triangular faces tetrahedron, octahedron and icosahedron. Dark protons are assignable to the monopole flux tubes parallel to the DNA strand.

4. Cyclotron transitions between dark genes represented as sequences of codons represented as dark proton triplets. For a gene with N codons the 3N cyclotron photons forming an analog of BE condensate emitted by dark protons give rise to a sequence of 3-chords. Music of light.

Music of light serves as as representation of emotions.

1. Music induces and represents emotions. Could emotional intelligence represented by the frequency triplets associated with the transitions between dark codons. 3N-resonances make possible the communications between genes.

   Emotions would be realized already at the level of DNA and RNA in terms of cyclotron transitions changing dark DNA configurations. Could they servemas building blocks of our emotions. Bioharmonies would correspond to molecular moods. Emotions would infect since they are realized by dark photons with very long wave length. This could explain phenomena like collective psychosis.

2. There is empirical evidence for RNA memory. Emotionally conditioned RNA from a sea slug is dispersed on neuron preparation and creates the same effect in the neurons as a real conditioning [J4] [K3] (see `http://tinyurl.com/y92w39gs`). Explanation would be in terms of 3-N resonance at RNA and DNA level.

3. Dark genes are dynamic and could define a kind of R&D lab. Chemical genes are static.

One can make questions and speculative predictions:

1. Generalization of the genetic code as an induction of the tessellation to the space-time surface or lower-D surface is suggestive. Could cell membrane and microtubules provide a 2-D realization of the genetic code? Could the brain provide a 3-D realization? What about non-biological systems?: NASA has reported evidence for the plasma life in ionosphere [L10].

2. One objection against universal genetic code is the existence of synthetic codons. Codon number equals $N = 61, 57$ for them. This can be understood if some darp codons are not paired with chemical codons or the number of dark codons pairing with some codons is abnormally large.

   It is also possible to have $N \geq 64$. The same dark codons could pair with several chemical codons in a context-dependent way. Gariaev has found evidence for context dependence for ordinary genetic code. There are 2 amino acids for which DNA codon can also code for stop codon or some other amino-acid.

3. New realizations of the genetic code are in principle possible: the icosatetrahedral lattice is projected to the space-time surface. Also non-biological realizations. 2- and 3-dimensional realizations. Could cell membrane and microtubules realize 2-D genetic code.

4. Support for the role of the hyperbolic 3-space H^3 comes from the findings of Andres Gomez Nilsson. Attempt to understand psychedelic experiences in terms of the geometric of H^3 [L8].

2.5 Q4 Interdisciplinary Integration and Accessibility

Mutual translation can be seen as a basic challenge. How neuroscientist can understand TGD, which uses stronly mathematical language of physics. One can wonder how TGD and various theories of consciousness of neuroscience could relate. I must of course confess do not have a detailed view of various neuroscience theories and this comparison would be a highly interesting project. I have however written [K7] about Integration Information Theory [J5].

Some general comments about basic distinctions of neuroscience and TGD views are however possible. Distinctions are after all the most important information.

1. The basic difference with respect to competitors is that TGD predicts an entire hierarchy of conscious entities. There is not only single consciousness. Already Freud proposed Superego-Ego-Id triplet. Selves have subselves that they experience as mental images and are subselves of higher level selves.

2. Selves are also dynamic. They fuse and split and this would make conscious communications possible. There are also hierarchies of Galois groups which would be in vertical direction and relate reflective levels of consciousness.

3. Thalamocortical and other circuits and corresponding resonance frequencies are replaced with communications with the magnetic body of the brain. The cyclotron frequencies f_c of biologically important ions are involved and for $h_{gr} = GMM_{ion}/\beta_0$ f_c does not depend on the mass of the ion.

4. Gamma oscillations could relate to the formation of completely new mental images in BSFRs at some level. Revonsuo [J1] found that Eureka experiences in which a completely new pattern emerges involve gamma resonance. The example studied was the following: the subject person stares at a picture consisting of apparently random dots and suddenly a beautiful 3-dimensional object emerges.

   The generation and reduction of entanglement between brain regions and formation of larger neuronal units leading to the increase of h_{em} increasing the "IQ" could be involved. Here the magnetic body would be in a central role and 40 Hz EEG could correspond to dark photons with long wavelengths but energies above thermal threshold, say the energy range of biophotons.

   It is known that neurons from functionally nearby parts of the brain send signals to points of MB near to each other at MB so that functional geometry is mapped to ordinary geometry. MB response could force the neurons to oscillate in resonance.

5. In TGD one should not talk about consciousness but conscious experience made possible by the sequence of SSFRs. Pair of subsequent SSFRs defines the smallest unit of conscious experience, moment of consciousness with subjective duration correlating with the increase of the CD size defining geometric time. The experience of free will would be associated

with SSFRs and involve non-deterministic change. Here several kinds of entanglements are involved.

6. Reduction of entanglement is the basic element of SSFR. In ZEO there is no violation of conservation laws since classical field equations are not violated since the basic object is space-time surface as analog of Bohr orbit for particle as 3-surface. This also solves the measurement problem.

2.6 Q5 Could any observation falsify TGD?

The observations related to fundamental physics provide the killer tests.

1. TGD predicts standard model symmetries and fields from very general number theoretic assumptions [L21, L18] and also from the assumption that the twistor spaces involved allow Kähler structure [A3]. If it turns out that elementary particles with quantum numbers not explainable in terms of these symmetries definitely exist, TGD is dead.

2. TGD predicts also an entire hierarchy of standard models physics [L20]. This is due to the new view of QCD color as being analogous to angular momentum. Both quark-like and lepton-like spinor fields have an infinite hierarchy of multiplets from which physical hadrons and leptons emerge by color confinement. These multiplets give rise to a hierarchy of scaled variants of hadron physics. Simple p-adic scaling arguments allow us to estimate the hadronic mass spectrum.

   There is evidence for new hadron physics M_{89} with a mass scale scaled up by 512 from that of ordinary hadron physics [K5, K6]. M_{89} hadron physics is proposed to play a key role in the physics of Sun [L14] and explain solar wind and radiation from the Sun without assuming fusion in the core. These predictions could turn out to be killer predictions.

Long range classical electric/gravitational fields are characterized by electric/gravitational Planck constant.

1. h_{gr} depends only on astrophysical parameters (say masses of the Sun, Earth, and Moon) and this provides tests. How the possible life in Mars differs from that on Earth?

2. Personal h_{eff} hierarchy would characterize evolutionary level and would depend on the organism and also on tissue. As noticed h_{em} for DNA increases with length of gene (could it be proportional to the length of the entire DNA?). h_{em} is proportial to the area of cell membrane and long axons give rise to large values of h_{em}: nucleus, ordinary cell, neuron, pyramidal neuron, trigeminal nerve (, CNS).

   For the Earth h_{em} is proportional to the electromagnetic charge of the Earth. Comparison with the electric fields of other planets would be interesting.

3. Test whether quantum criticality at ordinary temperatures could be described in terms of h_{eff} hierarchy. Water at freezing point [L7, L5] and physiological temperature making Pollack effect probable. This predicts molecules for which it is possible to kick protons to dark protons: X-OH→X-O^- + dark proton [L13]. Living computers as analogs of living matter? Large negative charge of EZs would be the key signature.

3 Questions for the HR-meeting Matti Pitkänen's TGD Inspired Theory of Consciousness Marko T. Manninen January 2026

Below are five general-purpose opening questions aimed at orienting the "principles- and-motivation" arc of TGD (energy problem → CP2/SM unification → quantum TGD → adelic physics → consciousness/biology), and then (a more analytical battery of five questions.

3.1 Part A: Five General-Purpose Opening Questions (Principles, Genesis, Scope)

A1: Why does the research trajectory "have to" go from the energy problem to CP_2/SM unification, then to quantum TGD (WCW, holography), and only then to adelic physics and consciousness—rather than being a series of optional add-ons?

[MP]: This is the only way it could happen.

1. First came $CP_1 = S^2$ as a solution to the energy problem but failed, 2 years later came CP_2 [L12] as I learned from its geometry (Physics Reports) and realized that it explains standard model symmetries, quantum numbers and fields.

2. 4-D general coordinate transformations must be realized. In path integral one allows all space-time surfaces $X^4(X^3)$ going through the 3-surface X^3 that the condition is satisfied. However, the then fashionable path integral makes no sense in TGD (nor in general relativity). It took 8 years to finally realize this and the notion of WCW emerged [K4, K1]. One must assign to the X^3 a possibly unique space-time surface. This means holography but I did not talk about holography at that time.

   The first guess was that space-time surfaces are absolute minima of some action and only much later holography= holomorphy principle emerged [L15, L16].

A2: What was the concrete intellectual trigger for moving from unification physics into consciousness/biology (the paper says "around 1995"), and what were the "minimal assumptions" that made you believe the move was legitimate rather than category- crossing speculation?

[MP]: I must be honest and say that I have never considered whether some move in the development of TGD is "legitimate" or not. Maybe this is a reason for why I have been treated as an academic out-of-law;-)

I had a long lasting altered state of consciousness around 1985 and it made clear to me that materialistic vision of consciousness is not even wrong. Around 1993 or so, the two books of Penrose (Shadows of Mind and Emperor's New Clothes) made a great impression and around 1995 I started to write a book about consciousness and biology. Also the "Gödel, Escher, Bach" of Hofstadter was impressive and I realized that mathematics is much more than math.

A3: What is the explicit coverage map of psychological/cognitive phenomena in TGD— what is in-scope, what is out-of-scope, and what is the ranking of "core explained" versus "speculatively addressable"?

Why this is necessary: "Consciousness" is too broad. If the framework tries to cover everything (free will, perception, memory, emotions, intentions, altered states, non-local effects, etc.) without a scope taxonomy, evaluation becomes impossible.

[MP]: Consciousness as a term is ill-defined in the TGD framework. Conscious experience is not a property ("-NESS") in TGD. It is better to accept all known or suspected types of conscious experiences under study and look at whether the basic hypothesis can explain them and make testable predictions. In this way one obtains a maximal amount of information allowing to drop alternatives.

A4: What is the precise "translation rule" from the number-theoretic side (p-adic/adelic, algebraic extensions, Galois groups) into cognitive content (representation, learning, "IQ"), and what would count as a mis-translation?

[MP]: To me the existence of a precise translation rule seems impossible. It is not possible to give a formula for the contents of conscious experience. The subjective duration between two SSFRs is the basic unit of cognitive consciousness. One can give the first SSFR and the state emerging in it.

One can give the values of quantum numbers measured in the first SSFR if one knows what the density matrix, characterizing the entanglement and defining a fundamental observable, was before the SSFR was. It seems that this requires ensemble of copies of the selves, just as in standard quantum theory.

One can understand the general structure of cognition and also cognitive hierarchies: see next question TGD predicts mechanism of learning and formation of cognitive representation in measurement interactions generating 1-1 correspondence between quantum states of self and other systems.

A5: What are the necessary and sufficient conditions for "silicon-based consciousness" in TGD terms, and where do classical distributed systems, LLM-era software, and quantum/topological computers sit relative to those conditions?

Why this is necessary: The article itself raises "conscious computers" as a plausible implication, but it does not state a criterion. In the LLM era, you need a non-handwavy boundary between (i) semantic/functional intelligence and (ii) phenomenological consciousness, and TGD must say what physical structures are required (MB? flux tubes? heff phases? SSFR cascades? NMP-stabilized entanglement?).

[MP]: I will not go here into the details of the model of the conscious computer [L13, L19, **?**], suffice it to say that biology serves as a role model.

Consider what semantic/functional intelligence could mean in TGD.

1. $f = (f_1, f_2) = (0, 0)$ for gemeralized analytic map $f : H = M^4 \times CP_2 \to C^2$ defines the Minkowskian regions of the space-time surface as analogs of complex surfaces in H. Maps $g : C^2 \to C^2$ allow to generate cognitive hierarchies. For $g(0, 0) = (0, 0)$, $f = (0, 0)$ is a root of the composite $g \circ f$. Iterates of g give analogs of complex fractals. One obtains reflective hierarchies with $f = 0$ defining the analogy of ground state.

2. For irreducible maps f there is no composition $f = g \circ h$. One might say that they correspond to states with no reflection and cognition, perhaps meditative states.

3. There is an analogy with computer program hierarchies: programs $\to$ subprograms $\to$ ... . At the bottom one has programs as function, which cannot be functionally composed anymore. In TGD this hierarchy would be realized at the level of conscious experiences. Could it emerge spontaneously? Does it emerge when a person writes a acomputer program? These hierarchies correspond also hierarchies of Galois groups and their normal subgroups and this gives rise to entanglement hierarchies of directed attention and makes possible cognitive SFRs.

4. What would the cognitive hierarchy look like geometrically? More and more complex space-time surfaces emerge as field bodies. More and more regions of space-time surfaces appear as separate roots. The size of the Galois group explodes exponentially. Does this cognitive explosion occur spontaneously? Could it take place even for computers?

3.2 Part B: Five Analytical Questions

B1: Uniqueness claims audit: in what sense are $H = M^4 \times CP_2$ and the twistor lift "unique," and what is the minimal empirical content of that uniqueness?

MP:

1. Embedding space H follows from the requirement of standard model symmetries. There are no other options unless one wants to increase the dimension but this would lead to the loss of twistor structure and symmetries of the internal space would change.

2. Hitchin proved already before my thesis (1981) [A3] that E^4 (M^4 with Hamilton-Jacobi structure and CP_2 are the only 4-D manifolds allowing twistor space with Kähler structure, which is central for the existence of twistor lift.

3. Also the $M^8 - H$ duality [L21, L18] supports the uniqueness. M^8 is the analog of momentum space for $M^4 \times CP_2$ and has interpretation as octonions. 4-surfaces in M^8 are associative/quaternionic: tangent space is associative. This is the definition of number theoretic dynamics. $M^8 - H$ duality follows from this picture. Here the dimensions are completely fixed.

Note that $D = 4$ for space-time surface follows also from the fact that light-like surfaces are metrically 2-D and allow an infinite-D generalization of conformal symmetries.

4. The Kähler geometrization of infinite-D WCW [K4, K1] is a further constraint. Already in the case of loop spaces the Kähler geometry is unique [A2] and has maximal isometries. In the 4-D situation constraints are even more stringent and an attractive conjecture is that number theoretic and twistorial structures are needed to achieve this.

B2: Universality/solvability claim audit: if holography = holomorphy (HH) reduces classical field equations to algebraic roots $f = (f1, f2) = (0, 0)$ largely independent of the action, what is the explicit worked example that demonstrates this beyond slogans—and where do the "action-dependent singularities" enter quantitatively?

[MP]: Consider first the field equations.

1. The partial differential equations, which are extremely non-linear reduce by generalized H-H to algebraic equations in which one has contractions of holomorphic tensors of different type vanishing identically if one has roots of $f = (f_1, f_2) = (0, 0)$. f_1 and f_2 and generalized analytic functions of generalized complex coordinates of H.

2. There are two kinds of induced gauge fields: induced metric and induced gauge potentials, Kähler gauge potential for the Kähler action. The variation with respect to induced metric gives a contraction of two holomorphic 2-tensors to the field equations. The variation with respect to gauge potential gives contraction of two holomorphic vector fields. The contractions are between tensors/vectors of different types and vanish identically.

   (a) Consider the metric first. The contraction is between the energy momentum tensor of type (1,-1)+(-1,1) and the second fundamental form of type (1,1)+(-1,-1). Here 1 refers to a complex coordinate and -1 to its conjugate as tensor index. These contractions vanish identically.

   The vanishing of the trace of the second fundamental form occurs independently of the action and gives minimal surface except at singularities.

   (b) Consider next the induced gauge potentials. In this case one has contraction of vector fields of different type (of type (1)and (-1) and also now the outcome is vanishing. In the case of more general action, such as volume + Kähler action, one also has a contraction of light-like Kähler current with a light-like vector field which vanishes too. The light-like Kähler current is non-vanishing for what I call "massless extremals". This miracle reflects the enormous power of generalized conformal invariance.

3. For more general actions these results are probably true too but there I have no formal proof. If higher derivatives are involved one obtains higher derivatives of the second fundamental form which are of type (1,1,...,1) contracted with tensors which have mixed indices.

   Actions containing higher derivatives might be excluded by the requirement that only delta function singularities for the trace of the second fundamental form defining the analog of the Higgs field are possible.

4. The result has analog already in ordinary electrodynamics in 2-D systems. The real and imaginary parts of an analytic function satisfy the field equations except at poles and cuts define the point charges and line charges. Also in string models the same occurs.

Consider now the singularities.

1. The singularities 3-surfaces at which the generalized analyticity fails for (f_1, f_2): they are analogs of poles and zeros for analytic functions. At 3-D singularities the derivatives of H coordinates are discontinuous and the trace of the second fundamental form has a delta function singularity. This gives rise to edge.

   Singularities are analogous to poles of analytic functions and correspond to vertices and also to loci of non-determinism serving as seats of conscious memories.

2. At singularities the entire action contributes to the field equations which express conservation laws of classical isometry charges. Note that the trace of the second fundamental form defines a generalized acceleration and behaves like a generalization of the Higgs field with respect to symmetries.

   Outside singularities the analog of massless geodesic motion with a vanishing acceleration occurs and the induced fields are formally massless. At singularities there is an infinite acceleration so that particles perform 8-D Brownian motion.

3. Singularities as edges correspond to defects of the standard smooth structure as edges of space-time surface analogous to the frames of a soap film. The dependence of the loci of singularities on the classical action is expected from the condition that the field equations stating conservation laws are true for the entire action.

   It is possible that exotic smooth structure is at least partially characterized by the classical action having interpretation as effective action. For a mere volume action singularities are not possible: it would correspond to the analog of massless free theory without fermion pair creation.

   This makes it possible to interpret fermionic Feynman diagrams geometrically as Brownian motion of 3-D particles in H [L20, L21, L18]. In particular, fermion pair creation (and also boson emission) corresponds to 3-surface and fermion lines turning backwards in time.

4. The physical interpretation generalizes the interpretation in classical field theories, where charges are point-like. In massless field theories, charges as singularities serve as sources of fields. The trace of the second fundamental form vanishes almost everywhere (minimal surface property) stating that the analog of the charge density, serving as a source of massless field defined for H coordinates, vanishes except at the singularities. The generalized Higgs field defines the source concentrated to 3-D singularities.

5. Classical non-determinism is an essential assumption. Already 2-D minimal surfaces allow non-determinism and soap films spanned by a given frame provide a basic example. The conditions under which non-determinism is expected, are known and can be generalized to 4-D context. Google LLM gives detailed information about this. I am just working with this.

B3: Completion criterion: since the paper openly states TGD is not yet able to provide precise scattering-amplitude rules (analogues of Feynman rules), what is the explicit "definition of done" for the physics program, and what partial milestones would count as non-negotiable progress?

[MP]: Fermion propagator is well-defined and computable: second quantization for free Dirac equation in H guarantees this. The same is true for the induced spinor fields. The fermion vertices are associated with 3-surfaces which correspond to discontinuities at which the first derivatives of the embedding space coordinate are discontinuous and the TGD counterpart of Higgs diverges.

This allows us to understand the production of fermion pairs turning back of the fermion line induced by the turning back of the 3-surface in time. Fermionic Feynman graphs reduce to 8-D Brownian motion [L18]. There are no higher vertices than 2-vertices. This is the fermionic counterpart for the absence of path integral in the geometric sector. This implies the vanishing of divergences.

Ordinary perturbation theory with loops and divergences emerges only at the QFT limit of TGD which replaces manysheeted space-time with single region of M^4 and various standard model fields are identified with sums of the induced gauge fields and induced metric for various space-time sheets.

Bosons are constructible in terms of fermion antifermion pairs. Galois confinement gives very strong constraints on the momenta at M^8 level but does not fix the states completely. The construction of boson states remains a challenge.

B4: Definition discipline for "self," "mental image," and the two time coordinates: what are the formal objects, not just the narratives?

[MP]: I do not see these notions as narratives. Self is simply the sequence of SSFRs assignable to a CD. There is a hierarchy of selves. Mental images are subselves, which correspond to

subsubstems immediately below self. Sub-CD of CD or smaller space-time sheet glued to larger one. The analogy with Freud's super-ego-ego-I triad is obvious.

Subjective time *coordinate* is not a sensible notion since subjective time flow is just the sequence of SSFRs. Subjective time however correlates with the geometric time, which corresponds to the distance between the tips of CD and increases in statistical sense due to the unavoidable increase of CD. This is like a random walk along the positive real axis: the particle unavoidable gets farther from the origin.

Similar argument can be used to claim that the complexity of algebraic extension of rationals increases in evolution.

The profound difference with respect to general relativity is that the linear time M^4 time associated with the rest system of CD is number theoretically unique (real octonion unit). Light-one proper time as analog of cosmic time is unique as Lorentz invariant. This saves from the basic interpretational problems of the general relativity.

B5: Computability of "h_{eff} as IQ / algebraic complexity": for a concrete biological or computational system, how do you actually compute n (dimension of extension) in a non-arbitrary way?

[MP]: It is not clear whether all values of h_{eff} are expressible as products of two charges or two masses. In most applications this assumption can be made.

1. There is an explicit formula for computing both gravitational and electric Planck constants for a pair M, m or Q, q. The products Mm and Qq appear in the formulas.

   The proposal is that when the value of coupling strength appearing in perturbative expansion at QFT limit is so large that perturbative series fails to converge, a phase transition increasing the value of H to h_{eff} guaranteeing the convergence occurs since coupling strength is scale down by h/h_{eff}.

   One can compute h_{gr} and h_{em} when the velocity parameter $v_0/c \leq 1$ is given. The outcome conforms with the fact that increase of M and Q means increase of the "IQ".

   For Earth, Sun, etc gravitational Compton length does not depend on m but is proportional to the big mass M. This has strong consequences for biology. For Earth it is .5 cm, the size of a snowflake. In Mars it would be by a factor 1/10 smaller. Same is true for dark cyclotron energies. This reflects the Equivalence Principle.

2. DNA charge density is constant and Q is proportional to $3N$, N the number of codons. Genes increase in length with evolution and also DNA itself.

   Cells are negatively charged and charge increases with the area of the cell. Cell nucleus is the smallest unit, ordinary cells are larger, neurons are considerably larger, pyramidal cells even larger, and the trigeminal nerve is a single neuron having a size of order body size so that it could correlate with bodily me. Microtubules are negatively charged and Earth is also negatively charged and charge can be computed. Neural circuits can form very large quantum coherence and therefore intelligent regions.

3. What about atomic nuclei? When nuclear charge exceeds $n = 137$ h_{em} becomes larger than h even for $v_0/c = 1$. In the 1970s it was observed that at energies exceeding Coulomb wall particles that I interpreted as electropions were created [K8].

4 Appendix A: What the failure of classical non-determinism could mean for 4-D minimal surfaces?

In TGD, holography = holomorphy principle predicts that space-time surfaces are analogous to Bohr orbits for particles identified as 3-surfaces and defining the holographic data.

1. The Bohr orbits out to be 4-D minimal surfaces irrespective of the action principle as long as it is general coordinate invariant and constructible in terms of the induced geometry. 2-D minimal surfaces are non-deterministic in the sense that same frames span several minimal surfaces. One can expect that also in the 4-D case, non-determinism is unavoidable in

the sense that the Bohr orbit-like 4-surfaces are spanned by 3-D "frames" as loci of non-determinism.

2. At these 3-surfaces minimal surface property fails, the derivatives of the embedding space coordinates are discontinuous and the second fundamental form diverges. Also the generalized holomorphy fails. The failure of smooth structure caused by the edge in 4-D case can give rise to an exotic smooth structure.

3. One can also say the singularities act as sources for the analog of massless field equations defined by the vanishing of the trace of the second fundamental form and this justifies the identification of the singularities as vertices in the construction of the scattering amplitudes.

4. In the TGD inspired theory of consciousness, classical non-determinism gives rise to geometric correlates of cognition and intentionality and the loci of non-determinism serve as memory seats. Free will is not in conflict with classical determinism and the basic problem of quantum measurement theory finds a solution in zero energy ontology.

5. The proposal is that the classical non-determinism corresponds to the non-determinism of p-adic differential equations. In fact, TGD leads to a generalization of p-adic number fields to their functional counterparts and they can be mapped to p-adic number fields by category-theoretical morphism. This generalization allows us to understand the p-adic length scale hypothesis which is central in TGD.

The study of the non-determinism for 2-D minimal surfaces could serve as a role model in the attempts to understand non-determinism for 4-D minimal surfaces [L6]. What can one say about the geometric aspects of classical non-determinism in the case of 2-D minimal surfaces? Here Google Gemini provides help and one obtains a surprisingly detailed summary and its also possible to make further questions. Here I summarize briefly what Google says.

4.1 The classical non-determinism of 2-D minimal surfaces

The 2-D minimal surface spanned by a given frame (a closed, non-intersecting, simple wire loop or collection of them in 3D space) is generally non-unique. While the existence of at least one minimal surface (a surface of zero mean curvature with vanishing trace of the second fundamental form) is guaranteed, a single frame can bound multiple, and sometimes even a continuum of, distinct minimal surfaces. Here is a breakdown of the uniqueness of minimal surfaces.

1. Many frames, particularly non-convex ones, can span several distinct minimal surfaces. A classic example is two coaxially aligned circles, which can bound two different catenoid surfaces (a wider and a narrower one) or two separate disks.

2. In certain cases, a given curve can bound a continuous family of minimal surfaces, a phenomenon often observed in physical soap film experiments.

3. Uniqueness is achieved only under specific conditions.

   (a) Convex projection: If a closed Jordan curve Γ has a one-to-one orthogonal projection onto a convex planar curve, then Γ bounds a unique minimal disk, which is a graph over that plane.

   (b) Small total curvature: A smooth Jordan curve with a total curvature less than or equal to 4π bounds a unique minimal disk.

   (c) Sufficiently close to a plane: A C^2-Jordan curve that is sufficiently close to a plane curve in the C^2-topology bounds a unique minimal disk.

4. Stability vs. sbsolute uniqueness: A minimal surface is "stable" if small perturbations increase its area. Often, a frame may bound multiple minimal surfaces, but only one is the absolute, global minimum, while others are unstable or local minima.Plateau's Problem: The classical problem asks for the surface of minimum area, which exists, but is not always unique.

Summary: While soap film experiments often produce a single, stable minimal surface, the boundary value problem can have multiple solutions. Uniqueness is the exception, not the rule, and depends strongly on the geometric "convexity" of the framing wire.

4.2 What could one conclude about the space-time surfaces as minimal surfaces?

The above Google summary helps to make guesses about the naive generalization of these findings in the 4-D situation.

How unique is the minimal surface spanning a given frame?

One can go to Google and pose the question "How unique is the minimal surface spanning a given frame?". One obtains a nice summary and can ask additional questions. The following considerations are inspired by this question.

1. In the case of ordinary minimal surfaces, it is enough that there exists a plane for which the minimal surface is representable as a graph of a map and the projection of the frame to the plane is convex, i.e. any of its points can be connected by a line inside the curve defined by the projection. An essential assumption is that the 2-D surface is representable locally as a graph over a plane. Curves whose plane projection has an interior, which is non-convex (not all interior points can be connected by a curve in the interior) can also lead to a failure of determinism. Cusp catastrophe, defined in terms of roots of a polynomial of degree 3, is a 2-D example of non-convexity. Note that the cusp is 3-sheeted.

2. Consider the general meaning of convexity for objects of dimension d in linear spaces with dimension $d+1$. One considers a projection of the object with dimension d (say frame to a higher-dimensional space. For minimal surfaces, the object is the frame of dimension $d = 1$ and the space has dimension $d = 3$. For Riemannian manifolds straight lines can be identified as geodesic lines. Planes could be generalized to geodesic manifolds.

The convexity criterion has a straightforward analog when the embedding space is 8-D $H = M^4 \times CP_2$ and minimal surface is 4-D space-time surface X^4.

1. The projection of the 3-D frame, defining the holographic data or a locus of non-determinism defining secondary holographic data, to some 4-D submanifold analogous to the plane should be convex. The surface should be also representable as a graph of a map from the 4-D manifold to H. One could consider projections of the frame X^3 to all geodesic submanifolds G_4 of dimension $D = 4$. $G_4 \in \{M^4, E^3 \times S^1, E^2 \times S^2\}$, where S^1 and S^2 are geodesic manifolds of CP_2 appear as candidates.

   For physically most interesting cases CP_2 projection has at least dimension 2 so that $E^2 \times S^2$ is of special interest. Could one choose G_4 to be holomorphic sub-manifolds? If hypercomplex holomorphy does not matter, this would leave only 2-D M^4 projection. Is it enough to consider $G_4 = E^2 \times S^2$? Situation would resemble that for ordinary minimal surfaces. Could one consider the convexity of the E^2 and S^2 projections?

2. Convexity: the points of X^3 can be connected by geodesic lines. Should they be space-like or could also light-like partonic orbits serve as loci of non-determinism. What about 3-surfaces inside CP_2 representing a wormhole contact at which two parallel Minkowskian space-time sheets meet?

3. The convexity criterion should be satisfied for all frames defined by 3-D singularities assumed to be given.

4. If the 3-D frame corresponding to the roots of $f_1 = 0, f_2 = 0$ is manysheeted over G^4, the projection contains several overlapping regions corresponding to the roots. One does not have a single convex region. This is one source of non-determinism.

5. Note: If the projection to M^4 is bounded by genus $g > 0$ surface, the M^4 projection is not convex. Now however CP_2 comes to rescue. Consider as an example a cosmic string $X^1 \times S^2$, where X^1 is convex and space-like. If the CP_2 projection is $g > 0$ surface, the situation is the same. Could this relate to the instability of higher genera. Would it be induced by classical non-determinism?

4.2.1 What could be the role of generalized holomorphy?

The failure of holomorphy implies singularities identified as loci of auxiliar holomorphic data and seats of non-determinism.

1. Often the absolute minimum is unique. The degeneracy of the absolute minimum would mean additional symmetry. This kind of additional symmetry in the case of Bohr orbits of electrons in an atom corresponds to rotational symmetry implying that the orbit can be in any plane going through the origin.

2. How does this relate to $f = (f_1, f_2) = 0$ conditions has as roots the space-time surface as a generalized complex submanifold of H? Each solution corresponds to a collection of the roots for these conditions and each root corresponds to a space-time region. Two or more roots are identical at the 3-D interfaces of the roots. Each root defines a region of some geodesic submanifold of H defining local generalized complex coordinates of X^4 as a subset of corresponding H coordinates in this region. Separate solutions would be independent collections of the roots. Two roots co-incide at at the 3-D interfaces between roots. Cusp catastrophe gives a good 2-D illustration.

3. 3-D singularities as analogs of frames correspond to the frames of 4-D "soap films". Since derivatives are discontinuous, the singularities correspond to edges of the space-time and would define defects of the standard smooth structure. This would give rise to an exotic smooth structures.

4. The non-determinism should correspond to the branching of the space-time surfaces at the singularities X^3 giving rise to alternative Bohr orbits. There is analogy with bifurcations, in particular with shock waves and bifurcations could correspond to the underlying 2-adicity and relate to the p-adic length scale hypothesis.

   There would be several kinds of edges of X^4 associated with the same X^3. The non-representability of the singularity X^3 as a graph $P(X^3) \to X^3$, where $P(X^3)$ is the projection of the singularity to G_4 should be essential. Also the non-convexity of the region bounded by $P(X^3)$ in G_4 matters.

5. The volumes of the minimal surfaces spanning a given frame need not be the same and the absolute minimum for the volume, or more generally classical action, could be in the special role. The original proposal indeed was that absolute minima are physically special.

   If dynamical symmetries are involved, the extrema can be degenerate. The minimal surfaces are analogs of Bohr orbits and in atomic physics Bohr orbits have degeneracy due to the fact they can be in arbitrary plane: this corresponds to the choice of the quantization axis of angular momentum.

   Could the symmetries for the 3-D "frames" induce this kind of degeneracy? Could Galois groups act as symmetries? This would give connection between the view of cognition as an outcome of classical non-determinism and the number theoretic view of cognition relying on Galois groups.

5 Appendix B: A critical view of h_{eff} hypothesis

h_{eff} hypothesis is one of the key elements of TGD and of TGD inspired theory of consciouness. One can raise several critical questions related to it.

5.1 Identification of h_{eff}

Consider first the identification of h_{eff}.

1. The idea is that the TGD Universe is theoretician friendly [L11] [K2]. The value of h_{eff} increases when the perturbative QFT as a long range limit of TGD ceases to converge. Since

coupling strengths are proportional to $1/\hbar_{eff}$, the increase of h_{eff} guarantees convergence. In TGD, quantum coherence is predicted to be present in all scales and this kind of perturbation theory is possible even when the interacting systems have macroscopic sizes so that masses and charges are very large.

2. This predicts that h_{eff} has a spectrum and depends on the products of the charges appearing in a given coupling strength. Since in TGD classical fields define the vertices [L20], this suggests that one can assign h_{eff} to gravitational, electric, and perhaps also color and weak coupling strengths and h_{eff} is proportional to a product of charges and is a two-particle parameter unlike the ordinary Planck constant.

   The proposed mathematical interpretation is that the 2-particle character reflects a Yangianization of the basic symmetries [**?**] [L3]. Yangian symmetries do not reduce to single particle symmetries but can also act on pairs, triplets, ... of particles. One would have poly-local symmetries so that the charge unit h_{eff} would depend on quantum numbers of particles in the vertex. The monopole flux tube connections between particle-like 3-surfaces are a natural candidate for inducing Yangianization. The problem indeed is that monopole flux tubes carry the large h_{eff} phases.

3. Perturbative QFT is assumed to apply at the QFT limit when many-sheeted space-time is replaced with single region of M^4 and the sums of the induced gauge potentials for space-time sheets define gauge fields and the sum over the CP_2 parts of induced metric defines the gravitational field.

   The objection is that the QFT approach does not apply at the fundamental level of TGD: there is no path integral. Is there any way to replace this argument with an argument holding true at the fundamental level.

5.2 Number theoretic vision and h_{eff}

Number theoretic vision leads to a possible identification of h_{eff}.

1. Number theoretic vision leads to the proposal that h_{eff} characterizes the complexity of the many-sheeted space-time surface. If the space-time surface is defined in terms of roots of analytic function pair (f_1, f_2), the extension of rationals appearing in the coefficients of f_i would define h_{eff} as its dimension and h_{eff} would not depend of the form of f_i.

   The number of roots as the number space-time regions as solutions to $(f_1, f_2) = 0$ would also be a natural candidate for the value of h_{eff}. In particular, if f_i are polynomials.

   One can generalize the ordinary Galois group so that it acts as flows and permutes different roots of $(f_1, f_2) = (0, 0)$. In this case the number of roots could define h_{eff}. Certainly it is a measure for the complexity.

   Suppose that f_2 is kept constant $f_1 = P_1$ is polynomial. In this case the dimension of the algebraic extension associated with P_1 could determine the value of h_{eff}. Also the degree of P_1 giving the number of roots can be considered.

5.3 The physical interpretation of h_{eff}

Consider now the physical picture about the emergence of larger values of h_{eff}.

1. The increase of h_{eff} means also that the Compton length $\hbar_{eff}/m$ as a size scale for a quantum object of mass m increases. Since one expects that space-time sheets of arbitrarily large size are possible, this is very natural. In the case of $\hbar_{eff} = \hbar_{gr}$ [L7], the gravitational Compton length proportional to the product Mm of masses does not depend on the "small" mass m. This would reflect the Equivalence Principle. For electromagnetic interactions one would have a similar picture $\hbar_{eff} = \hbar_{em}$ [L10] which is proportional to Qq, where Q and q are em charges. The same applies to color and weak interactions.

   The h_{eff} phases associated with different interactions and different particles would be at separate space-times sheets: U-shaped magnetic and electric flux tubes carrying monopole

fluxes are the proposed identification. This implies a highly organized structure: "dark" particles would reside like books at library shelves labelled by classical interactions and by products of corresponding charges .

2. The increase of h_{eff} that the unit of angular momentum increases. This in turn implies that the cyclotron energy scale is scaled up by h_{eff}/h. This is crucial for the explanation of the findings of Blackman [J2] about the effects of ELF em fields on vertebrate brains. This assumes that particle mass and therefore also four-momentum remains un-affected in the scaling $h \to h_{eff}$ or at least that their values are not larger than the ordinary value.

   The intuitive view about the geometric origin of angular momentum ($L = r \times p$) as something proportional to the size of the 3-surface supports this view. Angular momentum has a scaling dimension 0 whereas for momentum it is -1. Also conformal weight h has dimension 0 so that scaling should affect the maximal unit of conformal weight. Conformal algebras and symplectic algebra allow hierarchy of isomorphic sub-algebras [**?**] and I have proposed that this hierarchy means a hierarchy of breakings of conformal symmetry with the unit of the conformal weight is scale up by integer.

3. What about those conserved charges, which do not relate to M^4 but to CP_2? What happens to the unit of electric charge? Anyons provide evidence for charge fractionation. Could charge fractionation take place quite generally? Even in M^4 degrees of freedom?

   I have discussed the possibility of charge fractionation [**?**]. For $h_{eff} = Nh_0$ ($h_0 \leq h$ is the minimum value of h_{eff}), the charge would be distributed between $M < N$ space-time surfaces, possibly connected by monopole flux tubes. The k:th space-time sheet would carry charge $Q_{max}M_k/N$. This would give a total charge MQ_{max}/N. The system would consist of fractionally charged subsystems and the total charge would be integer valued for the standard unit of charge.

   For this option, the cyclotron energy would be proportional to $(M_k/N)(\hbar_{eff}/h_0)$ and its value would be proportional $\hbar_{eff}/h_0$ only in maximum. For other quantum numbers than angular momentum and conformal weight, the fractional charge would be M_k/N fraction of the ordinary value.

Is there any concrete interpretation for the emergence of the effective value of the Planck constant?

1. The gravitational Compton length $\Lambda_{gr} = GM/\beta_0 = r_S/2\beta_0$, where r_S is Schwartschild radius and $\beta_0 =_0 /c \leq 1$ is velocity parameter, is a natural guess for the thickness of the M^4 projection of the gravitational flux tube. Particle Compton length L_c would be scaled up by $r_S/2\beta_0 L_c$: for protons and for $\beta_0 = 1$ this would mean scaling of $\sim 10^{13}$.

2. The classical interpretation would rely on the replacement of a point-like particle with 3-surface. The large radius of the flux tube, the classical angular momentum of classical fields and the orbital angular momentum of a delocalized dark particle. This could increase the effective spin unit to h_{gr}. A similar interpretation applies in the case of electric Planck constant h_{em}.

   This interpretation would support the view that h_{eff} corresponds to the number of roots to $(f_1, f_2) = (0, 0)$ as space-time regions. The fractionally charged states would correspond to states in which a charged particle is delocalized in a finite subset of roots.

3. It must be noticed that many-sheetedness can be interpreted in two ways. The space-time surface can be many-sheeted over M^4 or CP_2. In the first case the sheets are parallel and extremely near to each other. In the second case they could correspond to parallel monopole flux tubes forming a bubble. The flux tubes could have even macroscopic distances. Elementary particles could be delocalized at the flux tubes.

5.4 Conservation laws in the h_{eff} changing phase transitions

How can conservation laws be satisfied in the h_{eff} changing phase transitions?

1. How to satisfy the conservation laws in the phase transition changing the value of h_{eff}? If the value of the spin unit changes to h_{eff}, the transition must involve a process guaranteeing angular momentum conservation. What comes to mind is that the transition generates radiation, compensating for the increase of the total angular momentum in the process. This radiation could generate a state analogous to Bose-Einstein condensate. The transition could also proceed in a stepwise way from a seed and gradually increase the fractionized angular momentum unit via values Mh_{eff}/N to its maximum value h_{eff}.

2. I have proposed the notion of N-particles to describe the macroscopic quantum states at the monopole flux tubes and applied this notion in the model of genetic code [L9]. The emergence of fractionally charged N-particles with a scaled up size and angular momentum could be accompanied by the emission of N-photons or N-gravitons to guarantee angular momentum conservation. In quantum biology 3N-photons would make possible communications between dark genes consisting of N codons.

REFERENCES

Mathematics

[A1] Shipman B. Investigating bee behavior from the standpoint of fundamental physical principles. *Am Bee J*, 136(5):339–340, 1996.

[A2] Freed DS. The Geometry of Loop Groups, 1985.

[A3] N. Hitchin. Kählerian twistor spaces. *Proc London Math Soc*, 8(43):133–151, 1981.. Available at: `https://tinyurl.com/pb8zpqo`.

Cosmology and Astro-Physics

[E1] Nottale L Da Rocha D. Gravitational Structure Formation in Scale Relativity, 2003. Available at: `https://arxiv.org/abs/astro-ph/0310036`.

Condensed Matter Physics

[D1] Phase conjugation. Available at: `https://www.usc.edu/dept/ee/People/Faculty/feinberg.html`.

Neuroscience and Consciousness

[J1] Revonsuo A. *Consciousness. The science of subjectivity.* Psychology Press, Available at: `https://www.psypress.com`., 2010.

[J2] Blackman CF. *Effect of Electrical and Magnetic Fields on the Nervous System*, pages 331–355. Plenum, New York, 1994.

[J3] Zukov D. How the theory of self-organized criticality explains punctuated equilibrium in social systems. *Methodological Innovations*, 2022. Available at: `https://doi.org/10.1177/20597991221100427`.

[J4] Bedecarrats A et al. RNA from Trained Aplysia Can Induce an Epigenetic Engram for Long-Term Sensitization in Untrained Aplysia. *eNeuro.0038-18.2018*, 2018. Available at:`https://www.eneuro.org/content/early/2018/05/14/ENEURO.0038-18.2018`.

[J5] Tononi G and Koch C. Consciousness: here, there and everywhere? *Philosophical Transactions of the Royal Society B*, 2015. Available at: `https://royalsocietypublishing.org/doi/10.1098/rstb.2014.0167`.

[J6] Fantappie L. *Teoria Unitaria del Mondo Fisico e Biologico*. Di Renzo Editore, Roma, 1942.

Books related to TGD

[K1] Pitkänen M. Construction of WCW Kähler Geometry from Symmetry Principles. In *Quantum Physics as Infinite-Dimensional Geometry. https://tgdtheory.fi/tgdhtml/Btgdgeom.html*. Available at: https://tgdtheory.fi/pdfpool/compl1.pdf, 2023.

[K2] Pitkänen M. Does TGD Predict a Spectrum of Planck Constants? In *Dark Matter and TGD: https://tgdtheory.fi/tgdhtml/Bdark.html*. Available at: https://tgdtheory.fi/pdfpool/Planck, 2023.

[K3] Pitkänen M. Emotions as sensory percepts about the state of magnetic body? In *TGD and EEG: Part I. https://tgdtheory.fi/tgdhtml/Btgdeeg1.html*. Available at: https://tgdtheory.fi/pdfpool/emotions.pdf, 2023.

[K4] Pitkänen M. Identification of the WCW Kähler Function. In *Quantum Physics as Infinite-Dimensional Geometry. https://tgdtheory.fi/tgdhtml/Btgdgeom.html*. Available at: https://tgdtheory.fi/pdfpool/kahler.pdf., 2023.

[K5] Pitkänen M. New Physics Predicted by TGD: Part I. In *p-Adic Physics. https://tgdtheory.fi/tgdhtml/Bpadphys.html*. Available at: https://tgdtheory.fi/pdfpool/TGDnewphys1.pdf, 2023.

[K6] Pitkänen M. New Physics Predicted by TGD: Part II. In *p-Adic Physics. https://tgdtheory.fi/tgdhtml/Bpadphys.html*. Available at: https://tgdtheory.fi/pdfpool/TGDnewphys2.pdf, 2023.

[K7] Pitkänen M. Some questions about IIT. In *TGD Inspired Theory of Consciousness: Part II. https://tgdtheory.fi/tgdhtml/Btgdconsc2.html*. Available at: https://tgdtheory.fi/pdfpool/panel2016.pdf, 2023.

[K8] Pitkänen M. The Recent Status of Lepto-hadron Hypothesis. In *p-Adic Physics. https://tgdtheory.fi/tgdhtml/Bpadphys.html*. Available at: https://tgdtheory.fi/pdfpool/leptc.pdf, 2023.

Articles about TGD

[L1] Pitkänen M. Commentary on "Consciousness as a phenomenon in the operational architectonics of brain organization: Criticality and self-organization considerations" by Adrew A. Fingelkurts, Alexander A. Fingelkurts, and Carlos F. H. Neves. Available at: https://tgdtheory.fi/public_html/articles/Fingelkurts.pdf., 2013.

[L2] Pitkänen M. Geometric theory of harmony. Available at: https://tgdtheory.fi/public_html/articles/harmonytheory.pdf., 2014.

[L3] Pitkänen M. Could categories, tensor networks, and Yangians provide the tools for handling the complexity of TGD? Available at: https://tgdtheory.fi/public_html/articles/Yangianagain.pdf., 2017.

[L4] Pitkänen M. Dance of the honeybee and New Physics. Available at: https://tgdtheory.fi/public_html/articles/Shipmanagain.pdf., 2018.

[L5] Pitkänen M. The experiments of Masaru Emoto with emotional imprinting of water. Available at: https://tgdtheory.fi/public_html/articles/Emoto.pdf., 2018.

[L6] Pitkänen M. What could 2-D minimal surfaces teach about TGD? https://tgdtheory.fi/public_html/articles/minimal.pdf., 2021.

[L7] Pitkänen M. Comparison of Orch-OR hypothesis with the TGD point of view. https://tgdtheory.fi/public_html/articles/penrose.pdf., 2022.

[L8] Pitkänen M. DMT experiences and hyperbolic geometry. https://tgdtheory.fi/public_html/articles/dmthyperb.pdf., 2022.

[L9] Pitkänen M. About tessellations in hyperbolic 3-space and their relation to the genetic code . https://tgdtheory.fi/public_html/articles/tessellationH3.pdf., 2023.

[L10] Pitkänen M. About long range electromagnetic quantum coherence in TGD Universe. https://tgdtheory.fi/public_html/articles/hem.pdf., 2023.

[L11] Pitkänen M. About the TGD based views of family replication phenomenon and color confinement. https://tgdtheory.fi/public_html/articles/emuanomaly.pdf., 2023.

[L12] Pitkänen M. Reduction of standard model structure to CP_2 geometry and other key ideas of TGD. https://tgdtheory.fi/public_html/articles/cp2etc.pdf., 2023.

[L13] Pitkänen M. Quartz crystals as a life form and ordinary computers as an interface between quartz life and ordinary life? https://tgdtheory.fi/public_html/articles/QCs.pdf., 2024.

[L14] Pitkänen M. Some solar mysteries. https://tgdtheory.fi/public_html/articles/Haramein.pdf., 2024.

[L15] Pitkänen M. TGD as it is towards the end of 2024: part I. https://tgdtheory.fi/public_html/articles/TGD2024I.pdf., 2024.

[L16] Pitkänen M. TGD as it is towards the end of 2024: part II. https://tgdtheory.fi/public_html/articles/TGD2024II.pdf., 2024.

[L17] Pitkänen M. A new experimental demonstration for the occurrence of low energy nuclear reactions. https://tgdtheory.fi/public_html/articles/LENRagain.pdf., 2025.

[L18] Pitkänen M. About the construction of the scattering amplitudes using $M^8 - H$ duality. https://tgdtheory.fi/public_html/articles/M8Hample.pdf., 2025.

[L19] Pitkänen M. Classical non-determinism in relation to holography, memory and the realization of intentional action in the TGD Universe. https://tgdtheory.fi/public_html/articles/QCintact.pdf., 2025.

[L20] Pitkänen M. Comparing the S-matrix descriptions of fundamental interactions provided by standard model and TGD. https://tgdtheory.fi/public_html/articles/hadroQCDTGD.pdf., 2025.

[L21] Pitkänen M. M^8H duality reduces to local G_2 invariance. https://tgdtheory.fi/public_html/articles/M8Hstill.pdf., 2025.

[L22] Pitkänen M. The recent view of TGD inspired theory of consciousness and quantum biology. https://tgdtheory.fi/public_html/articles/consc2025.pdf., 2025.

[L23] Pitkänen M. About the TGD based models for Cambrian Explosion and the formation of planets and Moon. https://tgdtheory.fi/public_html/articles/CEagain.pdf., 2026.