Questions about Matti Pitkänen's TGD Inspired Theory of Consciousness

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Matti Pitkänen

orcid:0000-0002-8051-4364.
email: matpitka6@gmail.com,
url: http://tgdtheory.com/public_html/,
address: Valtatie 8, as. 2, 03600, Karkkila, Finland.

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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.

1.1 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 [L2] 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 [K2, 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 [L4, L5].

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 [L3, L7, **?**], 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 → subprograms → ... . 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?

1.2 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) [A2] 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 [L1] 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 [K2, K1] is a further constraint. Already in the case of loop spaces the Kähler geometry is unique [A1] 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 [L8, L1, L6]. 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 [L6]. 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 [K3].

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