The latest progress in TGD

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Contents

1 Introduction

During last years the understanding of the mathematical aspects of TGD and of its connection with the experimental world has developed rapidly. Therefore it seems appropriate give an overall view about the developments as links (mostly) to blog postings. Below I list blog links to Quantum TGD, its applications to physics, to biology and to consciousness theory with the intention to give an overall view about the development of the ideas (I did not receive the final form of TGD from heaven and have been forced to work hardly for almost four decades!).

2 Basic Quantum TGD

TGD differs in several respects from quantum field theories and string models. The basic mathematical difference is that the mathematically poorly defined notion of path integral is replaced with the mathematically well-defined notion of functional integral defined by the Kähler function defining Kähler metric for WCW ("worlds of classical worlds"). Apart from quantum jump, quantum TGD is essentially theory of classical WCW spinor fields with WCW spinors represented as fermionic Fock states.

It has been clear from the beginning that the gigantic super-conformal symmetries generalizing ordinary super-conformal symmetries are crucial for the existence of WCW Kähler metric [**?**, **?**, **?**]. The detailed identification of Kähler function and WCW Kähler metric has however turned out to be a difficult problem.

It is now clear that WCW geometry can be understood in terms of the analog of AdS/CFT duality between fermionic and space-time degrees of freedom (or between Minkowskian and Euclidian space-time regions) allowing to express Kähler metric either in terms of Kähler function or in terms of anti-commutators of WCW gamma matrices identifiable as super-conformal Noether super-charges for the symplectic algebra assignable to $\delta M^4_{\pm} \times CP_2$. The string model description of gravitation emerges and also the TGD based view about dark matter becomes more precise. Also the proposal that sparticles correspond to dark matter becomes much stronger: sparticles actually are dark variants of particles.

1. Recent View about Kähler Geometry and Spin Structure of "World of Classical Worlds"

2. The vanishing of super-conformal charges as a gauge conditions selecting preferred extremals of Kähler action

3. About the twistorial description of light-likeness in 8-D sense using octonionic spinors
4. Updated view about the Kähler geometry of "world of classical worlds"
5. What TGD is and what it is not
6. What TGD is and what it is not
7. Updated View about Kähler geometry of WCW
8. The relation between U- and M-matrices
9. Could one define dynamical homotopy groups in WCW?
10. How it went?
11. Tensor nets and S-matrices
12. Tetrahedral equation of Zamolodchikov
13. Could $\mathcal{N} = 2$ super-conformal algebra be relevant for TGD?

2.1 TGD counterpart of Dirac action

The identification of the counterpart of Dirac action has been the fundamental challenge of TGD [**?**, **?**, **?**]. Super-conformal symmetry is a strong guide line. The first guess was that Dirac action would be what I have called Kähler-Dirac action with gamma matrices replaced by contractions of canonical momentum currents of Kähler action with imbedding space gamma matrices.

Second guide line is that electromagnetic charge should be well-defined for the spinor modes. This requires that Dirac action is localized at string world sheets at which classical W boson fields or perhaps also $Z0$ field vanish (this might still allow 4-D Kähler-Dirac action). Also integrability conditions must be satisfied and canonical momentum currents must be tangential to the stringy surfaces. The construction of preferred extremals would rely on holography quite concretely: string world sheets, partonic 2-surfaces, and possibly also their light-like orbits are fixed, and space-time surface is constructed using this data. The vanishing of symplectic conformal charges for sub-algebra of super-symplectic algebra isomorphic with the algebra itself would fix the space-time surface to a high degree.

In the case of the induced gamma matrices super-conformal symmetry suggests that Dirac action is accompanied by a bosonic term which is string world sheet area. This term would be however 4-dimensional. The solution of the apparent paradox is strong form of holography: Kähler action for preferred extremals is expressible as string area in effective metric given by the anti-commutators of Kähler-Dirac gamma matrices. This would realize TGD counterpart of AdS/CFT correspondence.

I considered also the possibility of giving up the original picture and introducing ordinary string area action to TGD. This would bring in gravitational constant to the theory as fundamental coupling parameter and the ration $\hbar G/R^2$ (R is CP_2 "radius") would be fixed by quantum criticality. This is however not consistent

with the AdS/CFT inspired idea that the strings connecting partonic 2-surfaces are responsible for the formation of gravitational bound states. For ordinary Planck constant only gravitational bound states of order Planck length would be possible. Even for $h_{eff} = n \times h$ is not enough. For $1/h_{eff}^2$ proportionality of the effective string area predicted by Kähler action, the size of bound states is of order GM/v_0 for $\hbar_{eff} = \hbar_{gr} = GMm/v_0$ applying in planetary system.

One can also ask whether one should pose the condition that the octonionic spinor structure relevant for the definition of twistors as 8-D notion is equivalent with the ordinary one [**?**]. The first too string conclusion was that string world sheets must carry vanishing induced gauge fields and have 1-D CP_2 projection. This would be strange but would not trivialize scattering amplitudes in TGD framework. String world sheets would be possible only in Minkowskian regions. Kähler function would not be affected by the string area term at all.

The holomorphy of spinor modes allows however to realize the equivalence of octonionic and ordinary spinor structures. In particular, the problems relating to associativity and caused by the presence of the induced gauge potentials can be circumvented.

A simple argument shows that the Kähler-Dirac action gives rise to physical degrees of freedom only if the super-symplectic symmetries are broken in the sense that only a sub-algebra with conformal weights coming as multiples of some integer n identified in terms of h_{eff} annihilate the physical states. The identification in terms of dark matter is obvious. Even sparticles could be identified as composites of ordinary particles and interior fermions.

Also the old idea that the generators (in technical sense of the word) of the super-symplectic algebra correspond to zeros of Riemann zeta. This leads to the notion of conformal confinement: only states for which the sum of conformal weights giving essentially mass squared is real number (non-negative integer) energy are physical states.

1. String world sheets, partonic 2-surfaces and vanishing of induced (classical) weak fields
2. Second quantisation of Kähler-Dirac action
3. About the twistorial description of light-likeness in 8-D sense using octonionic spinors
4. Updated view about the Kähler geometry of "world of classical worlds"
5. Hierarchies of conformal symmetry breakings, Planck constants, and inclusions of hyperfinite factors of type II_1
6. Updated view about the Kähler geometry of "world of classical worlds"
7. Holography and Quantum Error Correcting Codes: TGD View
8. Tensor nets and S-matrices
9. ER=EPR in TGD framework

10. Non-commutative space and strong form of holography
11. Is there a duality between associative and co-associative space-time surfaces?
12. Could categories, tensor networks, and Yangians provide the tools for handling the complexity of TGD?
13. http://matpitka.blogspot.fi/2017/06/are-higher-structures-needed-in.html

2.2 Symmetries of TGD

TGD differs from string models in that there is a gigantic generalization of super-conformal symmetries [**?**, **?**]. Conformal symmetries are actually extended in highly non-trivial manner to their 4-D counterparts and one can say that complex numbers are replaced with quaternions. These symmetries decompose to two parts corresponding to super-conformal symmetries associated with space-time interior (Kähler action) and those associated with string world sheets (string world sheet area).

1. About the notion of four-momentum in TGD framework
2. What went wrong with symmetries?
3. The vanishing of super-conformal charges as a gauge conditions selecting preferred extremals of Kähler action
4. Updated view about the Kähler geometry of "world of classical worlds"
5. Field equations as conservation laws, Frobenius integrability conditions, and a connection with quaternion analyticity
6. Are Preferred Extremals Quaternion-Analytic in Some Sense?

2.3 Number theoretic vision

Number theoretic vision involves three strands: p-adic physics, classical number fields, and infinite primes.

2.3.1 p-Adic physics

Number theoretic universality states that besides reals and complex numbers also p-adic number fields are involved (they would provide the physical correlates of cognition). Furthermore, scattering amplitudes should be well-defined in all number fields be obtained by a kind of algebraic continuation [**?**]. I have introduced the notion of intersection of realities and p-adicities which corresponds to some algebraic extension of rationals inducing an extension of p-adic numbers for any prime p. Adelic physics is a strong candidate for the realization of fusion of real and p-adic physics and would mean the replacement of real numbers with adeles. Field equations would hold true for all numer fields and the space-time surfaces would

relate very closely to each other: one could say that p-adic space-time surfaces are cognitive representations of the real ones.

I have had also a stronger vision which is now dead. This sad event however led to a discovery of several important results.

1. The idea has been that p-adic space-time sheets would be not only "thought bubbles" representing real ones but also correlates for intentions and the transformation of intention to action would would correspond to a quantum jump in which p-adic space-time sheet is transformed to a real one. Alternatively, there would be a kind of leakage between p-adic and real sectors. Cognitive act would be the reversal of this process. It did not require much critical thought to realize that taking this idea seriously leads to horrible mathematical challenges. The leakage takes sense only in the intersection, which is number theoretically universal so that there is no point in talking about leakage. The safest assumption is that the scattering amplitudes are defined separately for each sector of the adelic space-time. This means enormous relief, since there exists mathematics for defining adelic space-time.

2. This realization allows to clarify thoughts about what the intersection must be. Intersection corresponds by strong form of holography to string world sheets and partonic 2-surfaces at which spinor modes are localized for several reasons: the most important reasons are that em charge must be well-defined for the modes and octonionic and real spinor structures can be equivalent at them to make possible twistorialization both at the level of imbedding space and its tangent space.

   The parameters characterizing the objects of WCW are discretized - that is belong to an appropriate algebraic extension of rationals so that surfaces are continuous and make sense in real number field and p-adic number fields. By conformal invariance they might be just conformal moduli. Teichmueller parameters, positions of punctures for partonic 2-surfaces, and corners and angles at them for string world sheets. These can be continued to real and p-adic sectors and

3. Fermions are correlates for Boolean cognition and anti-commutation relations for them are number theoretically universal, even their quantum variants when algebraic extension allows quantum phase. Fermions and Boolean cognition would reside in the number theoretically universal intersection. Of course they must do so since Boolean thought and cognition in general is behind all mathematics!

4. I have proposed this in p-adic mass calculations for two decades ago. This would be wonderful simplification of the theory: by conformal invariance WCW would reduce to finite-dimensional moduli space as far as calculations of scattering amplitudes are considered. The testing of the theory requires classical theory and 4-D space-time. This holography would not mean that one gives up space-time: it is necessary. Only cognitive and as it seems also fundamental sensory representations are 2-dimensional. All that one can mathematically say about reality is by using data at these 2-surfaces. The rest is needed but

it require mathematical thinking and transcendence! This view is totally different from the sloppy and primitive philosophical idea that space-time could somehow emerge from discrete space-time.

This has led also to modify the ideas about the relation of real and p-adic physics.

1. The notion of p-adic manifolds was hoped to provide a possible realization of the correspondence between real and p-adic numbers at space-time level. It relies on the notion canonical identification mapping p-adic numbers to real in continuous manner and realizes finite measurement resolution at space-time level. p-Adic length scale hypothesis emerges from the application of p-adic thermodynamics to the calculation of particle masses but generalizes to all scales [**?**].

2. The problem with p-adic manifolds is that the canonical identification map is not general coordinate invariant notion. The hope was that one could overcome the problem by finding preferred coordinates for imbedding space. Linear Minkowski coordinates or Robertson-Walker coordinates could be the choice for M^4. For CP_2 coordinates transforming linearly under $U(2)$ suggest themselves. The non-uniqueness however persists but one could argue that there is no problem if the breaking of symmetries is below measurement resolution. The discretization is however also non-unique and makes the approach to look ugly to me although the idea about p-adic manifold as cognitive chargt looks still nice.

3. The solution of problems came with the discovery of an entirely different approach. First of all, realized discretization at the level of WCW, which is more abstract: the parameters characterizing the objects of WCW are discretized - that is assumed to belong to an appropriate algebraic extension of rationals so that surfaces are continuous and make sense in real number field and p-adic number fields.

   Secondly, one can use strong form of holography stating that string world sheets and partonic 2-surfaces define the "genes of space-time". The only thing needed is to algebraically extend by algebraic continuation these 2-surfaces to 4-surfaces defining preferred extremals of Kähler action - real or p-adic. Space-time surface have vanishing Noether charges for a sub-algebra of supersymplectic algebra with conformal weights coming as n-ples of those for the full algebra- hierarchy of quantum criticalities and Planck constants and dark matters!

   One does not try to map real space-time surfaces to p-adic ones to get cognitive charts but 2-surfaces defining the space-time genes to both real and p-adic sectors to get adelic space-time! The problem with general coordinate invariance at space-time level disappears totally since one can assume that these 2-surfaces have rational parameters. One has discretization in WCW, rather than at space-time level. As a matter fact this discretization selects punctures of partonic surfaces (corners of string world sheets) to be algebraic points in some coordinatization but in general coordinate invariant manner.

4. A further nice rasult is that one can understand imagination in terms of p-adic pseudo constants but in much more refined manner. The possibility of pseudo-constants suggests strongly that almost any collection of string world sheets and partonic 2-surfaces (briefly 2-surfaces) allows a holographic continuation to a p-adic preferred extremals of Kähler action. Preferred extremal property in real case however implies strong correlations between the 2-surfaces involved and in the generic case the continuation to a real space-time surface is not expected to be possible. The 2-surfaces continuable to various p-adic space-time surfaces but not real one represent imaginable but not realizable. The state function reduction to the opposite boundary would give as outcome 2-surfaces which allow also a continuation to real space-time surface. This is a killer test in quite concrete sense since the mental image representing intention is transformed to real action.

5. The vision about evolutionary hierarchy as a hierarchy of algebraic extensions of rationals inducing those of p-adic number fields become clear. The algebraic extension associated with the 2-surfaces in the intersection is in question. The algebraic extension associated with them become more and more complex in evolution. Of course, NMP, negentropic entanglement (NE) and hierarchy of Planck constants are involved in an essential manner too. Also the measurement resolution characterized by the number of space-time sheets connecting average partonic 2-surface to others is a measure for "social" evolution since it defines measurement resolution.

There are two questions, which I have tried to answer during these two decades.

1. What makes some p-adic primes preferred so that one can say that they characterizes elementary particles and presumably any system?

2. What is behind p-adic length scale hypothesis emerging from p-adic mass calculations and stating that primes near but sligthly below two are favored physically, Mersenne primes in particular. There is support for a generalization of this hypothesis: also primes near powers of 3 or powers of 3 might be favored as length sand time scales which suggests that powers of prime quite generally are favored.

The adelic view led to answers to these questions. The answer to the first question has been staring directly to my eyes for more than decade.

1. The algebraic extension of rationals allow so called ramified primes. Rational primes decompose to product of primes of extension but it can happen that some primes of extension appear as higher than first power. In this case one talks about ramification. The product of ramified primes for rationals defines an integer characterizing the ramification. Also for extension allows similar characteristic. Ramified primes are an extremely natural candidate for preferred primes of an extension (I know that I should talk about prime ideals, sorry for a sloppy language): that preferred primes could follow from number theory itself I had not though earlier and tried to deduce them from

physics. One can assign the characterizing integers to the string world sheets to characterize their evolutionary level. Note that the earlier heuristic idea that space-time surface represents a decomposition of integer is indeed realized in terms of holography!

2. Also infinite primes seem to find finally the place in the big picture. Infinite primes are constructed as an infinite hierarchy of second quantization of an arithmetic quantum field theory. The infinite primes of the previous level label the single fermion - and boson states of the new level but also bound states appear. Bound states can be mapped to irreducible polynomials of n-variables at n:th level of infinite obeying some restrictions. It seems that they are polynomials of a new variable with coefficients which are infinite integers at the previous level.

   At the first level bound state infinite primes correspond to irreducible polynomials: these define irreducible extensions of rationals and as a special case one obtains those satisfying so called Eistenstein criterion: in this case the ramified primes can be read directly from the form of the polynomial. Therefore the hierarchy of infinite primes seems to define algebraic extension of rationals, that of polynomials of one variables, etc.. What this means from the point of physics is a fascinating question. Maybe physicist must eventually start to iterate second quantization to describe systems in many-sheeted space-time! The marvellous thing would be the reduction of the construction of bound states - the really problematic part of quantum field theories - to number theory!

The answer to the second question requires what I call weak form of NMP.

1. Strong form of NMP states that negentropy gain in quantum jump is maximal: density matrix decompose into sum of terms proportional to projection operators: choose the sub-space for which number theoretic negentropy is maximal. The projection operator containing the largest power of prime is selected. The problem is that this does not allow free will in the sense as we tend to use: to make wrong choices!

2. Weak NMP allows to chose any projection operator and sub-space which is any sub-space of the sub-space defined by the projection operator. Even 1-dimensional in which case standard state function reduction occurs and the system is isolated from the environment as a prize for sin! Weak form of NMP is not at all so weak as one might think. Suppose that the maximal projector operator has dimension n_{max} which is product of large number of different but rather small primes. The negentropy gain is small. If it is possible to choose $n = n_{max} - k$, which is power of prime, negentropy gain is much larger!

   It is largest for powers of prime defining n-ary p-adic length scales. Even more, large primes correspond to more refined p-adic topology: $p = 1$ (one could call it prime) defines discrete topology, $p = 2$ defines the roughest p-adic topology, the limit $p \to \infty$ is identified by many mathematicians in terms of reals. Hence large primes $p < n_{max}$ are favored. In particular primes near but below powers

of prime are favored: this is nothing but a generalization of p-adic length scale hypothesis from $p = 2$ to any prime p.

A further interesting question is what makes ramified primes so special. Here the answer would be that the action of Galois group at the ends of space-time surfaces for which parameters belong to a prime ideal defined by ramified prime is trivial. n space-time surfaces collapse to single 3-surface at their ends and one obtains the classical realization of quantum criticality and n additional discrete degrees of freedom.

1. p-Adic length scale hypothesis for twin primes
2. Is evolution 3-adic?
3. Could adelic approach allow to understand the origin of preferred p-adic primes?
4. How preferred p-adic primes could be determined?
5. Updated Negentropy Maximization Principle
6. What could be the origin of p-adic length scale hypothesis?
7. Breakthroughs in the number theoretic vision about TGD
8. More about physical interpretation of algebraic extensions of rationals
9. p-Adic physics as physics of cognition and imagination
10. Gaussian Mersennes in cosmology, biology, nuclear, and particle physics
11. Congruence subgroups of SL(2,R), Monster Moonshine, Gaussian Mersennes, and p-adic physics
12. Could one realize number theoretical universality for functional integral?
13. Algebraic universality and the value of Kähler coupling strength
14. Some applications of Number Theoretical Universality
15. Are the zeros of Riemann zeta number theoretically universal?
16. Does Riemann Zeta Code for Generic Coupling Constant Evolution?
17. Why the non-trivial zeros of Riemann zeta should reside at critical line?
18. Is non-associative physics and language possible only in many-sheeted space-time?
19. Why Mersenne primes are so special?
20. How Ramanujan did it?

21. p-Adicizable discrete variants of classical Lie groups and coset spaces in TGD framework
22. Is the sum of p-adic negentropies equal to real entropy?
23. Langlands program and TGD
24. Comments about Ben Goertzel's ideas related to p-adic physics
25. Boolean algebras, Stone spaces and TGD
26. Mersenne integers and brain
27. p-Adic logic and hierarchy of partition algebras
28. NMP and self
29. Progress in Adelic TGD
30. About some unclear technical issues of TGD
31. What could be the role of complexity theory in TGD?
32. http://matpitka.blogspot.fi/2017/04/h-eff-hn-hypothesis-and-galois-group.html
33. Why would primes near powers of two (or small primes) be important?
34. Philosophy of Adelic Physics
35. About McKay and Langlands correspondences in TGD framework
36. Could McKay correspondence generalize in TGD framework?

2.3.2 Quaternions and octonions

The dimensions of the basic geometric objects in TGD suggest strongly that classical number fields should be crucial for understanding of TGD [**?**]. The basic dynamical principle would be requirement of associativity for the tangent space or normal space space-time surface in imbedding space with octonionic tangent space. This would give space-time surfaces as quaternionic surfaces. String world sheets would in turn be commutative surfaces with spinor connection which should be also consistent with associativity/co-associativity.

1. Quaternions octonions and TGD
2. Could the lines of generalised Feynman diagrams correspond to quaternion-Kähler manifolds?
3. Could quaternion analyticity make sense for the preferred extremals?
4. Classical number fields and associativity and commutativity as fundamental law of physics
5. Field equations as conservation laws, Frobenius integrability conditions, and a connection with quaternion analyticity

2.4 Twistors and TGD

8-dimensional generalization of ordinary twistors is highly attractive approach to TGD [**?**]. The reason is that M^4 and CP_2 are completely exceptional in the sense that they are the only 4-D manifolds allowing twistor space with Kähler structure. The twistor space of $M^4 \times CP_2$ is Cartesian product of those of M^4 and CP_2. The obvious idea is that space-time surfaces allowing twistor structure if they are orientable are representable as surfaces in H such that the properly induced twistor structure co-incides with the twistor structure defined by the induced metric. This condition would define the dynamics, and the conjecture is that this dynamics is equivalent with the identification of space-time surfaces as preferred extremals of Kähler action. The dynamics of space-time surfaces would be lifted to the dynamics of twistor spaces, which are sphere bundles over space-time surfaces. What is remarkable that the powerful machinery of complex analysis becomes available.

The condition that the basic formulas for the twistors in M^8 serving as tangent space of imbedding space generalize. This is the case if one introduces octonionic sigma matrices allowing twistor representation of 8-momentum serving as dual for four-momentum and color quantum numbers. The conditions that octonionic spinors are equivalent with ordinary requires that the induced gamma matrices generate quaternionic sub-algebra at given point of string world sheet. This is however not enough: the charge matrices defined by sigma matrices can also break associativity and induced gauge fields must vanish: the CP_2 projection of string world sheet would be one-dimensional at most. This condition is symplectically invariant. Note however that for the interior dynamics of induced spinor fields octonionic representations of Clifford algebra cannot be equivalent with the ordinary one.

One can assign 4-momentum both to the spinor harmonics of the imbedding space representing ground states of superconformal representations and to light-like boundaries of string world sheets at the orbits of partonic 2-surfaces. The two four-momenta should be identifical by quantum classical correspondence: this is nothing but a concretization of Equivalence Principle. Also a connection with string model emerges.

Twistor approach developed rapidly during years. Witten's twistor string theory generalizes: the most natural counterpart of Witten's twistor strings is partonic 2-surface. The notion of positive Grassmannian has emerged and TGD provides a possible generalization and number theoretic interpretation of this notion. TGD generalizes the observation that scattering amplitudes in twistor Grassmann approach correspond to representations for permutations. Since 2-vertex is the only fermionic vertex in TGD, OZI rules for fermions generalizes, and scattering amplitudes are representations for braidings. Braid interpretation gives further support for the conjecture that non-planar diagrams can be reduced to ordinary ones by a procedure analogous to the construction of braid (knot) invariants by gradual un-braiding (un-knotting).

Twistor approach has hitherto left open the explicit construction of geometric 3-vertices of the scattering amplitudes and the question how 3-vertices and fermionic dynamics relate. A concrete realization of super-symplectic Yangian leads in terms of multi-stringy generators leads to a very concrete proposal for the 3-vertices of the twistorial scattering amplitudes in terms of commutators and co-commutators. The

old idea is that Universe could be performing arithmetics in an algebra involving besides product also co-product which is in well-defined sense "time-inverse" of the product. The natural identification of this algebra is as a super-symplectic Yangian and the product and co-product have interpretation in terms of basic 3-vertices.

It is easy to hear the comments of the skeptic listener in the back row.

1. The attribute "minimal" - , which could translate to minimal value of Kähler function - is dangerous. It might be very difficult to determine what the minimal diagram is - consider only travelling salesman problem or the task of finding the shortest proof of theorem. It would be much nicer to have simple calculational rules.

   The original proposal might help here. The generalization of string model duality was in question. It stated that that it is possible to move the positions of the vertices of the diagrams just as one does to transform s-channel resonances to t-channel exchange. All loops of generalized diagrams could be be eliminated by transforming the to tadpoles and snipped away so that only tree diagrams would be left. The variants of the diagram were identified as different continuation paths between different paths connecting sectors of WCW corresponding to different 3-topologies. Each step in the continuation procedure would involve product or co-product defining what continuation between two sectors means for WCW spinors. The continuations between two states require some minimal number of steps. If this is true, all computations connecting identical states are also physically equivalent. The value of the vacuum functional be same for all of them. This looks very natural.

   That the Kähler action should be same for all computational sequences connecting the same initial and final states looks strange but might be understood in terms of the vacuum degeneracy of Kähler action closed related to quantum criticality, which means infinite gauge degeneracy associated with the Yangian of a sub-algebra of super-symplectic algebra.

2. QFT perturbation theory requires that should have superposition of computations/continuations. What could the superposition of QFT diagrams correspond to in TGD framework?

   Could it correspond to a superposition of generators of the Yangian creating the physical state? After all, already quantum computer performs superpositions of computations. The fermionic state would not be the simplest one that one can imagine. Could AdS/CFT analogy allow to identify the vacuum state as a superposition of multi-string states so that single super-symplectic generator would be replaced with a superposition of its Yangian counterparts with same total quantum numbers but with a varying number of strings? The weight of a given superposition would be given by the total effective string world sheet area. The sum of diagrams would emerge from this superposition and would basically correspond to functional integration in WCW using exponent of Kähler action as weight. The stringy functional integral ("functional" if also wormhole contacts contain string portion, otherwise path integral) would give the perturbation theory around given string world sheet. One would have effective reduction of string theory.

1. Classical part of the twistor story (pdf)
2. Classical part of the twistor story (pdf)
3. Classical TGD and imbedding space twistors
4. Twistor spaces as TGD counterparts of Calabi-Yau spaces of string models
5. The classical part of the twistor story
6. Witten's twistor string approach and TGD
7. About the twistorial description of light-likeness in 8-D sense using octonionic spinors
8. Twistorial questions to ponder
9. Does number theoretical universality require the positivity of twistor Grassmann amplitudes?
10. What about non-planar-Feynman diagrams?
11. Permutations, braidings, and amplitudes
12. More detailed view about scattering amplitudes
13. Could the Universe be doing Yangian quantum arithmetics?
14. From Principles to Diagrams
15. Twistors and the relationship of TGD to GRT
16. Cosmic evolution of the radius of the fiber of the twistor space of space-time surface
17. Does M^4 Kähler form imply new physics?
18. Twistor googly problem transforms from a curse to blessing in TGD framework
19. How the hierarchy of Planck constants might relate to the almost vacuum degeneracy for twistor lift
20. Some questions related to the twistor lift of TGD
21. Generalized Kähler structure for Minkowski space and CP breaking and matter antimatter asymmetry
22. Symplectic structure for M4, CP breaking, matter-antimatter asymmetry, and electroweak symmetry breaking
23. Further details related to the induction of twistor structure
24. Twistor lift and the reduction of field equations by SH to holomorphy
25. How does the twistorialization at imbedding space level emerge?

26. A new view about color, color confinement, and twistors
27. Questions related to the quantum aspects of twistorialization
28. Questions related to the twistor lift of Kähler action
29. Criticizing the TGD based construction of twistor amplitudes
30. What causes CP violation?
31. Issues related to the precise formulation of twistor lift of TGD
32. Key ideas related to the twistor lift of TGD
33. Kerr effect, breaking of T symmetry, and Kähler form of M^4
34. About unitarity of twistor amplitudes
35. About the generalization of dual conformal symmetry and Yangian in TGD
36. Getting quantitative about violations of CP, T, and P
37. Getting even more quantitative about CP violation

2.5 Hierarchy of Planck constants, hyperfinite factors, dark matter, and SUSY

The idea bout hierarchy of Planck constants labeling phases of ordinary matter identified as dark matter is now more than ten years old [**?**]. The hypothesis about hierarchy of Planck constants emerged as two variants, which seem to be equivalent: the gravitational Planck constant h_{gr} emerging from the work of Nottale on astrophysics is equal to Planck constant $h_{eff} = n \times h$ emerging from neuroscience and biology (one can also introduce electromagnetic Planck constant h_{em}). This hypothesis has powerful consequences in TGD inspired quantum biology and theory of consciousness.

How to create dark matter? I have proposed several answers to this question. The most general proposal is that dark phases emerge automatically at quantum criticality and perhaps even at ordinary criticality [**?**]. The long range quantal correlations/fluctuations associated with large value of Planck constant would correspond to long range correlations associated with criticality.

Super-symplectic conformal invariance is essential aspect of criticality for 2-D systems and generalizes in TGD framework to all systems by effective 2-dimensionality implied by strong form of holography in turn implied by strong form of general coordinate invariance. Also a hierarchy of breakings of conformal invariance defined by sub-algebras of conformal algebra is predicted and corresponds to the hierarchy of Planck constants. What is surprising that the increase of $h_{eff} = n \times h$ corresponds to a reduction of criticality since super-conformal generators generating gauge symmetries begin to generate physical symmetries. Since it happens spontaneously, the generation of dark matter occurs spontaneously. In biology this means that the reduction of h_{eff} is what requires metabolic energy.

The emergence of dark matter means that the interior modes of the induced spinor fields become dynamical. An interesting conjecture is that sparticles correspond to bound composites of particles and interior fermions - right-handed neutrinos obeying Kähler-Dirac equation could generate $\mathcal{N} = 2$ SUSY in this manner. This could allow to understand why LHC has not produced neither dark matter nor sparticles and explain several particle physics anomalies.

The notion of finite measurement resolution is central in TGD. The inclusions of hyper-finite factors (HFFs) provide an attractive realization of the finite measurement resolution: the action of the included factor generates states not distinguishable from the original one and is analog of gauge group action. Discretization is the natural counterpart of the classical realization of finite measurement resolutions. Discretization is however realized for the parameters characterizing string world sheets and partonic 2-surfaces which provide dynamical discretization of space-time surface - not as discrete point set but a collection of 2-surfaces. 2-surfaces make possible braids and quantum group concept closely related to inclusions of HFFs.

This picture can be now formulated more precisely and makes a lot of very general predictions. In particular, the representations of quantum group should be obtained as one decomposes the representations of group with respect to discrete algebraic subgroup. This insight would explain explain and generalize some key observations about quantum group representations (finite number of spins for $SU(2)_q$).

R-matrix defining the action of braid group defines quantum group. A connection with p-adic physics emerges: in p-adic sectors the discretisation is always necessary since only discrete phases (rather than continuous angles) definable as roots of unity and their hyperbolic counterparts exist in the extensions of p-adic numbers. An infinite hierarchy of quantum groups associated with the algebraic extensions of rationals emerges if the interpretation is correct.

1. Are dark photons behind biophotons?

   Could photosensitive emulsions make dark matter visible?

2. Is $h_{eff} = h_{gr}$ hypothesis really consistent with TGD inspired quantum biology?

3. The behavior of superfluids in gravitational field

4. Does a phase transition generating dark matter occur accompany criticality

5. Criticality and dark matter

6. Could the magnetic flux quanta assigned with criticality carry monopole flux?

7. Mathematical approach to criticality

8. Is the formation of gravitational bound states impossible in superstring models?

9. Hierarchies of conformal symmetry breakings, Planck constants, and inclusions of hyperfinite factors of type II_1

10. Transition from flat to hyperbolic geometry and q-deformation

11. Macroscopically quantum coherent fluid dynamics at criticality?
12. Invisible magnetic fields as dark magnetic fields?
13. Dark matter is absorbed by blackhole slower than ordinary matter
14. The new findings about the structure of Milky Way from TGD viewpoint
15. Did Dragonfly 44 fail as a galaxy?
16. Nothing new at LHC?
17. Is the new physics really so elementary as believed?
18. What does one mean with quantum fluctuations in TGD framework?
19. More precise interpretation of gravitational Planck constant

2.6 TGD and GRT

Is Equivalence Principle (EP) true in TGD and what is its detailed form? This is one of the key questions, which found a partial answer only after I understood how the many-sheeted space-time of TGD gives rise to GRT space-time and gauge theory picture as an approximation [**?**]. The latest step of progress means detailed understanding of EP at the level of fundamental fermions. Tests for the notion of many-sheeted space-time are provided by predicted anomalies.

The dominance of string area action for M^4 type vacuum extremals, which were conjectured from the beginning to serve as excellent candidates for GRT space-time means that string theory type description is an excellent approximation for the theory of gravitation in macroscopic scales.

The question how geometrical description of gravitation can be consistent with particle physics description is not well-understood. Gravitational red-shift is not easy to understand solely in terms of gravitons whereas Poincare invariance natural in particle approach is difficult to understand in GRT approach. TGD allows to solve both problems.

1. Further progress concerning the relationship between TGD and GRT and Kähler-Dirac action
2. SN1987A and many-sheeted space-time
3. Is cosmic expansion a mere coordinate effect?
4. Neutrinos from the galactic center as a further piece of evidence for many-sheeted space-time?
5. Cosmic redshift as purely kinematic effect
6. About the twistorial description of light-likeness in 8-D sense using octonionic spinors
7. Manifest unitarity and information loss in gravitational collapse

8. Variation of Newton's constant and of length of day
9. GD view about blackholes and Hawking radiation: part I
10. TGD view about blackholes and Hawking radiation: part II
11. Sharpening of Hawking's argument
12. Where they are - the gravitational waves?
13. About Fermi-Dirac and Bose-Einstein statistics, negentropic entanglement, Hawking radiation, and firewall paradox in TGD framework
14. About the new proposal of Hawking, Perry, and Strominger to solve the black-hole information loss problem
15. Does quantum gravity look like a mission impossible because of our cherished beliefs?
16. What Fermilab's Holometer experiment has to do with Quantum Gravity?
17. LIGO and TGD
18. Is Planck length really fundamental length?
19. What could the gamma ray pulse detected .4 seconds after the LIGO merger mean?
20. Gravitational Waves from Black Hole Megamergers Are Weaker Than Predicted
21. The problem of two Hubble constants
22. Dark matter is absorbed by blackhole slower than ordinary matter
23. Cosmic redshift but no expansion of receding objects: one further piece of evidence for TGD cosmology
24. Does GRT really allow gravitational radiation?
25. Does GW150914 force to modify the views about formation of binary blackhole systems?
26. What happens to the extremals of Kähler action when volume term is introduced?
27. Emergent gravity and dark Universe
28. Does the presence of cosmological constant term make Kähler coupling strength a genuine coupling constant classically?
29. About minimal surface extremals of Kähler action
30. Do you already believe in emergent gravity?

31. Space-time engineering from space-time legos
32. Minimal surface analog of Schwartschild solution: two horizons and possible connection LIGO anomaly
33. LIGO blackhole anomaly and minimal surface model for star
34. Minimal surface cosmology
35. Is Lorentz invariant synchronization of clocks possible?
36. What about actual realization of Lorentz invariant synchronization?
37. How the QFT-GRT limit of TGD differs from QFT and GRT?
38. How the QFT-GRT limit of TGD differs from QFT and GRT?
39. Third gravitational wave detection by LIGO collaboration
40. Why should stars be borne in pairs?
41. How to demonstrate quantum superposition of classical gravitational fields?

3 Physics applications

TGD Universe is fractal so that TGD predicts new physics in all scales. In practice this means, that TGD can say something non-trivial about practically any anomaly of standard physics. This fact of course gives an effective weapon for the irritated skeptics: TGD solves all possible problems!

3.1 Particle physics

The number theoretically and twistorially unique choice $H = M^4 \times CP_2$ predicts standard model symmetries and family replication can be understood in terms of topology of partonic 2-surfaces. A lot of new physics is however predicted. p-Adic length scale hierarchy allows to understand particle massivation and predicts the possibility of scaled copies of hadron physics and electroweak physics. TGD color also differs from QCD color and predicts new particles as color excitations of ordinary ones (CP_2 spinor harmonics). The most important recent breakthrough already discussed is the understanding of the origin of preferred p-adic primes as ramified primes and of the generalization of p-adic length scale hypothesis stating that primes near but below powers of primes are favoured by NMP.

3.1.1 Higgs and TGD

TGD predicts Higgs but the description of particle massivation in terms of Higgs vacuum expectation value emerges only in the QFT approximation [**?**]. It is however important to understand the counterpart of Higgs vacuum expectation and it is now clear how it emerges from fermionic 2-vertex as discontinuity of Dirac operator at the partonic 2-surface defining vertex for generalized Feynman diagram.

CKM mixing for quarks reduces to different topological mixings for U and D type quarks [**?**, **?**]. CKM mixing occurs also for leptons and the observed decay of Higgs to $\tau\mu$ pair provides first evidence for this mixing.

The newest twist in the development is the realization that Higgs in standard model framework is metastable: the sign of the quartic coupling λ at energy range $10^{10}-10^{12}$ GeV changes sign if standard model is correct and a new energy minimum emerges making the standard minimum meta-stable. This supports the view that coupling might vanish at CP_2 scale in the dynamics provided by TGD.

1. Could vacuum expectation value of Higgs have TGD counterpart?
2. TGD explanations of the anomalous decay of Higgs to $\tau-\mu$ pair and anomalies of B meson decays
3. Criticality of Higgs: is Planck length dogmatics physically feasible?
4. Still about induced spinor fields and TGD counterpart for Higgs
5. Could the two photon emissions of dark particles reveal the value of heff?
6. New pseudoscalar meson at LHC?

3.1.2 M_{89} hadron physics and new particles

M_{89} physics is scaled up counterpart of ordinary hadron physics assignable to Mersenne prime M_{107} with 512 times higher mass scale so that it could become visible at LHC [**?**]. TGD view about elementary particles allows also several exotic states: for instance, leptoquarks having lepton and quark at opposite boundaries of wormhole contact.

1. W boson excess at LHC and ATLAS: explanations?
2. Have leptoquarks been observed in the decays of B meson?
3. Does color deconfinement really occur?
4. Could leptoquarks be squarks in TGD sense?
5. Do I here M_{89} bells ringing?
6. Evidence for the η meson of M_{89} hadron physics

3.1.3 Hierarchy of Planck constants and particle physics

Hierarchy of Planck constants has the most interesting applications in TGD inspired quantum biology. I have however considered also particle physics applications. First application proposed long time ago is to the model of the anomalous electron pair production in heavy ion collisions in terms of leptopions which are pion-like bound states of colored excitations of leptons. The decay rates of weak bosons do not allow new light particles and a possible manner to understand this is to assume that the

colored excitations are dark in TGD sense [**?**]. If one identifies dark particles with $N = 2$ sparticles, these states are selectrons.

A further possible application relates to the reported large parity breaking effects in proton-proton collisions. Could it be that M_{89} hadrons with large Planck constant $h_{eff} = 2^9 \times h$ are created so that their size is same as that of ordinary hadrons? [**?**]

1. Large parity breaking in heavy ion collisions
2. Has dark matter particle been observed
3. Gaussian Mersennes in cosmology, biology, nuclear, and particle physics
4. Pion of $M_{G,79}$ hadron physics at LHC?
5. Further evidence that 2 TeV bump could be MG,79 pion
6. 5 TeV bump at CMS?
7. New indication for leptonic CKM mixing
8. Indication for a scaled up variant of Z boson
9. First indications for the breaking of lepton universality due to the higher weak boson generations
10. The latest CMS results concerning narrow dijet resonances
11. Do I here M_{89} bells ringing?
12. Newest LHC Run 2 rumours
13. Indications for the new physics predicted by TGD
14. M_{89} hadron physics is there and maybe also $M_{G,79}$ hadron physics!
15. Evidence for the eta meson of M89 hadron physics
16. New evidence for second generation weak bosons predicted by TGD
17. Direct evidence for Z' a la TGD and M89 J/Psi
18. Evidence for rho or omega meson of M_{89} hadron physics
19. Lightnings, dark matter, and lepto-pion hypothesis again
20. What if 750 GeV bump disappears?
21. CMS provides evidence for two new spin 2 mesons of M89 hadron physics
22. Could second generation of weak bosons explain the reduction of proton charge radius?
23. About parity violation in hadron physics
24. Getting even more quantitative about CP violation

25. Phase transition from M_{107} hadron physics to M_{89} hadron physics as TGD counterpart for de-confinement phase transition?

26. Anomalous J/Ψ production and TGD

27. Breaking of lepton universality seems to be real

28. Excess of cosmic ray antiprotons as a further support for M89 hadron physics?

3.1.4 SUSY and TGD

TGD predicts huge super-conformal symmetries but whether it predicts some variant of space-time SUSY has remained unclear [**?**, **?**]. The addition of right-handed neutrino to the wormhole throat carrying fermion would generate sfermion. Another possibility considered earlier is that right-handed neutrino is associated with the space-time interior. This option looks equally attractive and generalizes to all fermions in the sense that dynamical super-symmetries would correspond to the addition of interior fermions to the state defined by ordinary fermions at partonic 2-surfaces.

The outcome would be broken $N = 2$ SUSY. The fermionic oscillator algebra at partonic 2-surface would generate larger SUSY with bigger breaking. It is quite possible that spartners for $N = 2$ SUSY have same p-adic mass scale as particles. Hence one can ask whether these states have non-standard value of Planck constant so that they are dark and not observed in ordinary particle physics experiments.

In fact, dark matter could actually correspond to sparticles located at space-time sheets characterized by non-standard value of Planck constant understandable as n-fold covering spaces for which the sheets co-incide at the ends of CD. Each sheet would be actually conformal equivalence class of space-time sheets. This would reflect the non-determinism of Kähler action.

1. Standard SUSY or M_{89} hadron physics?

2. Could sparticles have same p-adic mass scale as particles and be dark matter in TGD sense?

3. About sterile neutrinos, SUSY partners, antimatter, and dark matter

3.2 Particle physics in general

Has IceCube detected neutrinos coming from decays of p-adically scaled up copies of weak bosons?

New results from PHENIX concerning quark gluon plasma

Experimental evidence for sterile neutrino?

Misbehaving b-quarks and proton's magnetic body

Leptonic CKM mixing and CP breaking?

Toponium at 30.4 GeV?

Critizing the view about elementary particles

Muon surplus in high energy cosmic ray showers as an indication for new hadron physics

Anomaly in neutron lifetime as evidence for the transformation of protons to dark protons

How the QFT-GRT limit of TGD differs from QFT and GRT?

Neutron production from an arc current in gaseous hydrogen: 66 year old nuclear physics anomaly

Encountering the puzzle of inert neutrinos once again

3.3 Nuclear physics

In nuclear string model nucleons form strings connected by color flux tubes with quark and antiquark at ends [**?**]. This predicts new nuclear physics 1-10 keV scale for which there is some evidence. This would also mean interaction with atoms since the wavelengths of photons are in the range 1-10 Angstrom.

1. Individual nucleons inside nuclei do not behave according to predictions
2. Tewari's space-energy generator for two decades later
3. Cold Fusion Again
4. How to design your own light saber?
5. Does electrolysis involve dark matter and new physics?
6. Solution of the Ni62 mystery associated with Rossi's E-Cat
7. Could cold fusion solve some problems of the standard view about nucleosynthesis?
8. Reactor antineutrino anomaly as indication for new nuclear physics predicted by TGD
9. Very strong support for TGD based model of cold fusion from the recent article of Holmlid and Kotzias
10. The discovery of X boson as a further evidence for nuclear string model
11. Pear-shaped Barium nucleus as evidence for large parity breaking effects in nuclear scales?
12. Is cold fusion taking place in 175 year battery still working?
13. 175 year old battery still working, Pollack's EZs, cold fusion, self-loading batteries, membrane potential, and nerve pulse
14. Hydrinos again

3.4 Condensed matter physics

p-Adic length scale hierarchy and dark matter hierarchy predict new physics also in condensed matter scales.

TGD predicts a mechanism of super-conductivity based on Cooper pairs at parallel magnetic flux tubes with either opposite or parallel magnetic fields [**?**, **?**]. Large value of Planck constant makes in principle possible to raise the cyclotron energy scale above thermal energy. One can understand the basic aspects of high Tc superconductivity in this model. How the gap energy emerges from cyclotron binding energy which for the values of h_{eff} considered would be much higher than thermal energy, is not yet well-understood.

The conjecture $h_{eff} = h_{gr}$ [**?**] leads to a model for the fountain effect of superfluidity in terms of macroscopic gravitational quantum coherence. Also Podkletnov effect [**?**] might be understand along same lines. Quite generally, critical systems could exhibit dark matter with large h_{eff} which would be responsible for long range quantum fluctuations. A possible interpretation would be in terms of interior modes of induced spinor field.

The recent finding that SmB_6 behaves very paradocixally at low temperatures in presence of magnetic field being conductor and insulator simultaneously has a trivial explanation in TGD framework - magnetic flux tubes as current wires. If so, this finding would be one further direct evidence for several new physics notions predicted by TGD: many-sheeted space-time and topological field quantization, strong form of holography and the generalization of AdS/CFT correspondence predicted by it, TGD as almost topological QFT at the level of single space-time sheet, and hierarchy of Planck constants predicted by quantum criticality of TGD and identified as dark matter hierarchy.

1. New finding about pseudo gap in high temperature super-conductivity
2. More precise view about high Tc superconductivity taking into account recent experimental results
3. The behavior of superfluids in gravitational field
4. Could Podkletnov effect be understood using h_{eff}= h_{gr} hypothesis?
5. Quantitative model of high T_cc super-conductivity and bio-super-conductivity
6. Does the physics of SmB_6 make the fundamental dynamics of TGD directly visible?
7. Strange behavior of SmB6 and new mechanism of quantum bio-control
8. Topological order and Quantum TGD
9. Flux tube description seems to apply also to low Tc superconductivity
10. Hydrogen sulfide superconducts at -70 degrees Celsius!
11. Quantal heat conduction in scale of one meter!

12. Nematicity and high Tc superconductivity
13. Indications for high Tc superconductivity at 373 K with $h_{eff}/h = 2$
14. Teslaphoresis and TGD
15. Badly behaving photons and space-time as 4-surface

    Have magnetic monopoles been detected?

    New findings about high-temperature super-conductors
16. Topological condensed matter physics and TGD
17. Induction coils in many-sheeted space-time
18. The anomalies in rotating magnetic systems as a key to the understanding of morphogenesis?
19. Could the presence of light affect weight?
20. Weight change for electrets and "weight of soul"
21. High Tc superconductivity in n-alkanes above 231 C
22. High Tc superconductivity in n-alkanes above 231 C
23. TGD and hydrogen atom as anomaly of QED
24. Anomalies of water as evidence for dark matter in TGD sense
25. Time crystals, macroscopic quantum coherence, and adelic physics

3.5 Cosmology and astrophysics

3.5.1 Cosmic strings, inflation, dark matter and dark energy

Cosmic strings [**?**, **?**] are key players of primordial TGD inspired cosmology and correspond to a phase in which space-time as we understand it, had not yet emerged. Gas of cosmic strings (having nothing to do with cosmic strings in the standard sense of the word) is the appropriate term.

BICEP2 collaboration claimed to have detected polarization of CMB, which could due to interaction with gravitons during inflationary period. It turned out that dust is a more plausible explanation. This claim however inspired more detailed development of the model for the TGD counterpart of the inflationary period.

During this period a phase transition from string gas gas phase to a radiation dominated cosmology took place. If one assumes that single sheeted space-time identified as vacuum extremal with Robertson-Walker type metric allows to model this period, one obtains a highly predictive model involving only single parameter identifiable as the duration of the transition period.

After primordial period the M^4 projection of cosmic strings thickened from string world sheets to 4-D regions of Minkowski space and the outcome was magnetic flux tubes carrying monopole flux. Monopole flux does not need any currents to

generate it unlike ordinary magnetic flux, and this could explain why magnetic fields appear in all length scales although the required currents coherent in long scales have not been possible. The magnetic energy of the flux tubes can be identified as dark energy and the dark matter at the flux tubes would correspond to large h_{eff} phases. The magnetic tension would correspond to the apparent "negative pressure" in the models assuming vacuum energy density due to inflaton field rather than cosmological constant.

1. BICEP2 might have detected gravitational waves
2. Could TGD allow inflationary cosmology
3. Quantum critical cosmology of TGD predicts also very fast expansion
4. Still about TGD and inflation
5. Planck 2013 estimates for string tension of various strings
6. Cyclic cosmology from TGD perspective
7. Correlated Polygons in Standard Cosmology and in TGD
8. Is inflation theory simply wrong?

3.5.2 Dark matter, cosmology and astrophysics

TGD view about dark matter and dark energy differs from the standard view [**?**, **?**, **?**]. For instance, the model for galactic dark matter assumes the dark matter to be condensed around cosmic string containing galaxies like pearls in necklace. The magnetic energy of the cosmic string could be in good approximation responsible for the gravitational field which is automatically such that constant velocity spectrum for distant stars is predicted. The deviation from a typical model of galactic dark matter is that there is no halo. The motion in the direction of the cosmic string is predicted to be free apart from the gravitational force created by galaxy itself. Galaxies would have emerged in the decay of cosmic strings to ordinary particle in a manner analogous to its emergence from the energy of inflaton field.

A rather spectacular support for the model comes from Pioneer and Flyby anomalies [**?**] allowing to estimate the density of the needed dark matter sphere. Estimate is consistent with the estimate for the effective surface density assignable to galactic dark matter and also with constraints from the model identifying bio-photons as decay products of dark photons [**?**].

1. Variation of Newton's constant and of length of day
2. Manifest unitarity and information loss in gravitational collapse
3. Pioneer and Flyby anomalies as demonstrations of dark matter spheres associated with orbits of planets
4. Evidence for astrophysical phase transitions of ordinary matter to dark matter?

5. Has the decay of dark photons to visible photons been observed in cosmological scales?
6. Long range correlations between spins of quasars
7. Surprising finding about gamma ray bursts
8. Further progress in the understanding of dark matter and energy in TGD framework
9. Could the interpretation of Planck mass be totally wrong?
10. TGD interpretation for the new discovery about galactic dark matter
11. Antimatter as dark matter
12. Bullet cluster and TGD based model of dark matter
13. Velocity curves of galaxies flatten for large redshifts
14. Early galactic collision gives support for TGD based model of galactic dark matter
15. Zwicky paradox and models of galactic dark matter
16. Missing dark matter
17. Breaking of CP, P, and T in cosmological scales in TGD Universe
18. Galactic blackholes as a test for TGD view about formation of galaxies?
19. TGD view about universal galactic rotation curves for spiral galaxies
20. New view about galaxies and galactic blackholes

3.5.3 New physics of Earth

It is known that astrophysical objects comove but do note expand themselves during cosmic expansion. TGD suggests that the expansion occurs but in quantum jerks as the p-adic length scale associated with the space-time sheet associated with the astrophysical object increases.

In the case of Earth this jerk-wise expansion could provide a physical justification for Expanding Earth model inspired by the observation that the continents fit nicely to cover entire surface of Earth if the radius is one half of its recent value [**?**]. This leads to a profound modification of the views about the history of geology, climate, and biological evolution. The emergence of highly developed species during Cambrian explosion could be seen as the burst of life developed in underground oceans caused by the rapid expansion of the radius of Earth. This could also explain the emergence of oceans.

Also the dynamics of the magnetic field of Earth could be understood as being controlled by dark magnetic body of Earth [**?**].

1. Maintenance problem for the Earth's magnetic field

2. Where did oceans come from?
3. New Horizons about Pluto
4. How did life evolve during pre-Cambrian period?
5. Mystery: How Was Ancient Mars Warm Enough for Liquid Water?

4 TGD inspired quantum biology

TGD inspired quantum biology involves several new physics elements. Zero energy ontology allows to see living systems as essentially 4-D objects and provide a new view about self-organization. Dark matter assumed to reside at large h_{eff} phase at the flux tubes of magnetic body is second key element. The most recent discovery is that the hierarchy of Planck constants defines hierarchy of criticalities so that the increase of h_{eff} means reduction of criticalities (system is however still critical but in longer scale) and thus occurs spontaneously. Therefore generation of dark matter is spontaneous process. In biology this means that metabolic energy is needed to reduce h_{eff} - for instance, to reduce the length of magnetic flux tubes connecting two biomolecules- so that chemical reaction becomes possible.

4.1 Dark matter, quantum gravitation, and life: h_{eff}=h_{gr} hypothesis

The emergence of life could be seen as emergence of large h_{eff} phases at magnetic flux quanta assignable to quantum criticality. $heff = h_{gr}$ hypothesis strengthens the predictions and gives a connection between dark photons and bio-photons [**?**].

1. Seth Lloyd on quantum life
2. Implications of strong gravimagnetism for TGD inspired quantum biology
3. Gravitational Mother Gaia and life
4. Quantum gravity, dark matter, and prebiotic evolution
5. Is h_{eff}= h_{gr} hypothesis really consistent with TGD inspired quantum biology?
6. More precise view about remote replication
7. New experimental information about chiral selection
8. TGD inspired comments on Mae-Wan Ho's talk about protons in water
9. Is the view about evolution as approach away from criticality consistent with biology?
10. Direct evidence for dark DNA?!
11. More Precise TGD Based View about Quantum Biology and Prebiotic Evolution

12. Could protein dynamics be dictated by the magnetic body of the protein with the mediation of water?
13. Evidence of ancient life discovered in mantle rocks deep below the seafloor
14. Quantum critical dark matter and tunneling in quantum chemistry
15. Gut cells having no mitochondria survive: evidence for quantum credit card mechanism
16. One step further in understanding the origins of life
17. Could the replication of mirror DNA teach something about chiral selection?
18. Taos hum as remote metabolism?
19. Why metabolism and what happens in bio-catalysis?
20. Two steps towards understanding of the origins of life

4.2 Pollack's findings about fourth phase of water

Pollack's findings about four phase of water allow a description in terms of emergence of dark phase of protons and provide support for the vision that genetic code is realized as sequences of dark protons with states of proton allowing grouping to multiplets in one-one correspondence with the basic bio-molecules [**?**].

1. Pollack's findings about fourth phase of water
2. Possible implications of Pollack's findings for pre-biotic life in TGD Universe
3. Pollack's findings and quantum model of cell membrane using square root of thermodynamics
4. Biochemical communications as a prerequisite for dark photon communications?
5. How transition from dark life to biochemical life could have taken place?
6. Are bacteria able to induce phase transition to super fluid phase?
7. Is there a connection between biology, dark fusion, and nuclear fusion?
8. How the fourth phase of water discovered by Pollack is formed?
9. Pollack's mechanism and photosynthesis
10. Metabolic energy is not information but is needed to transfer negentropic entanglement

4.3 ZEO, magnetic body, and biology

Zero energy ontology leads to a rather concrete view about self-organization as emergence of 4-D "behavioral" patterns (rather than 3-D patterns) [**?**]. If one accepts the idea about dark proton realization of genetic code one ends up with vision about water memory and evolution of immune system.

1. Morphogenesis, morphostasis, and learning in TGD framework
2. TGD view about homeopathy, water memory, and evolution of immune system
3. Cell memory and magnetic body
4. Magnetic body as genetic editor?
5. E_8 symmetry, harmony, and genetic code
6. What ZEO can give to the description of criticality?
7. What's new in TGD inspired view about phase transitions?
8. Quantum phase transitions and 4-D spin glass energy landscape
9. Mechanism for the transfer of genetic information from soma cells to germ cells
10. Bacteria behave like spin system: Why?
11. Gut cells having no mitochondria survive: evidence for quantum credit card mechanism
12. Evidence for the notion of magnetic body from brain synchrony without corpus callosum
13. One step further in understanding the origins of life
14. Could the replication of mirror DNA teach something about chiral selection?
15. More Reasons Why for Zero Energy Ontology
16. Is the impossible EM drive possible in TGD Universe?
17. Emergence of 3-space or only the emergence of experience about 3-space?
18. Brain metabolic DNA as an indication for genomic RD based on dark DNA
19. Could Chladni mechanism allow to realize morphogenesis?
20. Can quantum biology really do without new physics?
21. Are lithium, phosphate, and Posner molecule fundamental for quantum biology?
22. Induction coils in many-sheeted space-time

23. The anomalies in rotating magnetic systems as a key to the understanding of morphogenesis?

24. Could the presence of light affect weight?

25. Weight change for electrets and "weight of soul"

26. Bio-catalysis, morphogenesis by generalized Chladni mechanism, and bio-harmonies

27. Are viruses fragments of topological quantum computer code?

4.4 Microtubules in TGD

Microtubules as quantum antennas [**?**] represents one of the oldest ideas of TGD inspired quantum biology and relies on so called massless extremals [**?**]. There are new experimental findings about microtubules giving support for their identification as macroscopic quantum systems. TGD provides a possible interpretation of the findings.

1. Are microtubules macroscopic quantum system

2. Orch-Or theory of Penrose and Hameroff and new experimental findings about microtubules

3. A model for anesthetic action

4. Anesthetes again

5. Impressions from SSE-2016 conference

6. How AC voltage at critical frequencies could induce transition to microtubular superconductivity?

5 TGD inspired theory of consciousness

TGD inspired theory of consciousness could be seen as a generalization of quantum measurement theory forced by ZEO and the possibility of having unitary entanglement giving rise to degenerate density matrix for which natural number theoretic information measure provided by the p-adic analog of Shannon entropy exists. Negentropy Maximization Principle (NMP) would be the basic variational principle consistent with second law. NMP would imply evolution as an accumulation of potentially conscious information - "Akashic records".

5.1 The notion of self and NMP

The notion of self is central for TGD and it is now possible formulate this notion rather convincingly using ZEO based view about state function reduction. Negentropy Maximization Principle (NMP) [**?**] is the basic variational principle of TGD

inspired quantum measurement theory behind TGD inspired theory of consciousness. The possibility of NE stable under NMP would be crucial for the understanding of living systems and evolution.

There have been several steps of progress related to the notion of self.

1. As already explained, strong form of NMP states that negentropy gain in quantum jump is maximal. The problem is that this does not allow free will in the sense as we tend to use: to make wrong choices!

   Weak NMP allows to chose any projection operator and sub-space, which is any sub-space of the sub-space defined by the projection operator. Even 1-dimensional in which case standard state function reduction occurs and the system is isolated from the environment as a prize for sin! Surprisingly, weak form supports evolution since selves can choose the option for which negentropy of the final state is higher than otherwise. In particular, generalization of p-adic length scale hypothesis follows.

2. There is no need to assume interaction free measurements to read the NE. The sequence of state function reductions to fixed boundary CD defining self is enough to make NE conscious. Therefore the theory simplifies.

3. There is no need to keep the idea that p-adic-to-real transitions represent the transformation of intentions to actions and their reversals to the formation of thoughts. Sensory and cognitive aspects of existence are present as real and p-adic sectors of adelic space-time in all scales - even in elementary particle length scales as the success of p-adic mass calculations demonstrated already two decades ago - I am a slow learner!

   One gets rid of the notion of p-adic manifold based on the map of real manifold to its p-adic counter part since strong from of holography allows to construct both real and p-adic preferred extremals from string world sheets and partonic 2-surfaces as basic data in the intersection of reality and various p-adicities. Preferred p-adic primes can be understood: it might even be that the preferred extremals exist only for them.

1. Self or only a model of self?
2. How to construct Akashic records and read them?
3. Some critical questions relating to Maya and Akashic records
4. More precise formulation of Negentropy Maximization Principle
5. NMP and Consciousness
6. Negentropic entanglement, NMP, braiding and TQC
7. One Mind theory, Akashic records, and negentropic entanglement
8. What self is?
9. Is evolution 3-adic?

10. Intentions, cognitions, time, and p-adic physics
11. Connection between Boolean cognition and emotions
12. Can one identify quantum physical correlates of ethics and moral?
13. How preferred p-adic primes could be determined?
14. Could adelic approach allow to understand the origin of preferred p-adic primes?
15. Updated Negentropy Maximization Principle
16. Breakthroughs in the number theoretic vision about TGD
17. p-Adic physics as physics of cognition and imagination
18. Impressions created by TSC 2015 conference
19. About quantum measurement and quantum computation in TGD Universe
20. About negentropic entanglement as analog of an error correction code
21. Ontology-Epistemology duality?
22. About Fermi-Dirac and Bose-Einstein statistics, negentropic entanglement, Hawking radiation, and firewall paradox in TGD framework
23. Should we start to bury free will?
24. How Ramanujan did it?
25. TGD Inspired Comments about Integrated Information Theory of Consciousness
26. NMP and adelic physics
27. "Final" solution to the qualia problem
28. Number theoretical feats and TGD inspired theory of consciousness
29. Wigner's friend and Schrdinger's cat
30. Cloning of maximally negentropic states is possible: DNA replication as cloning of this kind of states?
31. Is cloning of love possible?
32. p-Adic physics as physics of cognition and imagination and counterparts of recursive functions
33. About interactions of selves and their time reversals (and few words about ghosts)
34. Chemical qualia as number theoretical qualia?

35. Quantum computations without definite causal structure and TGD

36. http://matpitka.blogspot.fi/2017/04/is-conscious-experience-without.html Is conscious experience without definite causal order possible?

37. http://matpitka.blogspot.fi/2017/07/retrocausality-and-tgd.html Retrocausality and TGD

5.2 The notion of time

ZEO provides a new view about state function reduction and leads also to the understanding of the connection between subjective time and geometric time and of the arrow of time [**?**].

1. Little but important step in the understanding the arrow of time

2. About time delays related to passive aspects of consciousness: once again

3. Questions and answers about time

4. Sensory organs as seats of primary sensory qualia and memory recall as seeing in time direction

5. Does the flow of subjective time correspond to the increase of the average value of effective Planck constant?

6. How time reversed mental images differ from mental images?

7. Deconstruction and reconstruction in quantum physics and conscious experience

8. Inverse Research on Decisions Shows Instinct Makes Us Behave Like Cyborgs, not Robots: Really?

9. Confirmation of Santilli's detection of antimatter galaxies via a telescope with concave lenses: really?

10. Re-incarnation as a basic prediction of TGD inspired theory of consciousness

11. What does Negentropy Maximization Principle really say?

12. NMP and self

13. WCW and the notion of intentional free will

5.3 Music, consciousness, emotions, cognition, genetic code

The observations that icosahedron has 12 vertices (number of notes in 12-note scale) and has 20 vertices (the number of amino-acids) led to a cascade of ideas [**?**, **?**] [**?**]. The outcome involves characterization of basic musical harmonics in terms of allowed 3-chords and a model for genetic code predicting it correctly in terms of symmetries of Hamiltonian cycles representing imbeddings of 12-note scale at icosahedron. This leads also to a proposal that basic bio-molecules could communicate by using music represented as 3-chords of dark photons with frequencies in the same range as audible frequencies. This would give a highly detailed realization of the vision about realization of genetic code in terms of frequencies.

1. Pythagoras, music, sacred geometry, and genetic code
2. Geometric theory of harmony
3. Genes music and icosahedron
4. Harmony music and religious myths
5. Combinatorial Hierarchy: two decades later
6. What could be the physical origin of Pythagorean scale?
7. Slime holds: conscious intelligence without central nervous system?

5.4 Magnetic body and neuroscience

EEG and its possible variants mediate dark photon communications between biological body and magnetic body having onion-like structure with layers which can be of the size of Earth and even exceed it. Together with ZEO this leads to rather interesting speculations.

1. Hypnosis as remote mental interaction
2. What is EEG made of?
3. Psychedelics induced experiences and magnetic body
4. How visual percepts are constructed?
5. The effects of psychedelics as a key to the understanding of remote mental interactions?
6. Do neurons have their own genomes?
7. Evidence for the notion of magnetic body from brain synchrony without corpus callosum
8. About physical representations of genetic code in terms of dark nuclear strings
9. Two proposals for physical realization of genetic code predicting correctly the numbers of codons coding given amino-acid

10. Non-locality in quantum theory, in biology and neuroscience, and in remote mental interactions: TGD perspective
11. Could dark DNA, RNA, tRNA and amino-acids correspond to different charge states of codons?
12. Are sound-like bubbles whizzing around in DNA essential to life?
13. Is bio-catalysis a shadow of dark bio-catalysis based on generalization of genetic code?
14. What about quantum entanglement between codons?
15. Comparing TGD view about quantum biology with McFadden's views
16. Further pieces of evidence for the notion of magnetic body
17. Magnetic body, biophotons, and prediction of scaled variant of EEG
18. Biophotons and evolution of intelligence
19. About double slit experiments of Dean Radin

6 Miscellaneous

1. New book about TGD
2. Three atmospheric puzzles with a common solution
3. How to design your own light saber?
4. Why trust a theory?
5. Palmer's Invariant Set Theory and TGD
6. Two styles of theorizing: conservative and radical
7. Laundry pile phenomenon and various dimensions
8. The world is really simple: even neural nets are able to model it!
9. Basic course in misunderstanding publicly what TGD is
10. Can one apply Occam's razor as a general purpose debunking argument to TGD?
11. Dogmatism, ego, and elite of mental images
12. Answer to a question about general aspects of TGD
13. Does Monster have place in TGD Universe?
14. Narcissism, ethics, and adeles
15. The future of physics according to Nima-Arkani Hamed