

## **A Brief Overview of Topological Geometrodynamics**

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### Abstract

Topological GeometroDynamics was born as a possible solution to the special-general relativity discrepancy. Space-time as a 4-D surface was the radically new vision about the fundamental ontology. The new view leads to notions like many-sheeted space-time, topological field quantization, sub-manifold gravity, geometrization of classical fields in terms of sub-manifold geometry and of standard model quantum numbers, and eventually to geometrization of Feynman diagrams in terms of space-time geometry having highly non-trivial implications also in the macroscopic length scales. The introduction of p-adic number fields leads to the generalization of the notion of space-time so that it also allowed p-adic regions for various values of p-adic prime. The construction of quantum TGD led to the idea about physics as a geometry of "world of classical worlds" (WCW). WCW could consist of space-time surfaces representing preferred extremals of certain action and the geometrization of WCW would also provide it with spinor structure - in well-defined sense square root of metric structure. WCW spinor fields (formally purely classical objects) would define the quantum states of the Universe. This vision generalizes the earlier ideas proposed by Wheeler in general relativity context. The new view about implies highly non-trivial predictions in all length scales. The new ontology is especially relevant for TGD inspired quantum biology and consciousness theory.

## 1 Introduction

As a young theoretical physicist I was disturbed by the obvious conflicts between the belief systems behind special and general relativities. I found it difficult to accept that the wonderfully successful symmetries of special relativity are lost in general relativity. Even stranger to me was to see the way my colleagues behaved - and still behave - as if this were not the case. For me this was the first lesson - one of the many to come - about the power of sociology in science: scientists are not at all as rational as they pretend to be. In the following I try to articulate my credo as beliefs about what exists and what can be known. These beliefs have formed during the 35 years of TGD development and I hope that they continue to evolve.

## 2 The basic ontology of TGD

TGD is my credo expressed using just three letters. TGD was born as a possible solution to the special-general relativity discrepancy. Space-time as a 4-D surface was the radically new vision about the fundamental ontology. From the beginning it was clear that it would force the rewriting of text books if it were correct, and I had excellent motivations to develop the idea. The new view led to notions like many-sheeted space-time, topological field quantization, sub-manifold gravity, geometrization of classical fields in terms of sub-manifold geometry and of standard model quantum numbers, and eventually to geometrization of Feynman diagrams in terms of space-time geometry having highly non-trivial implications also in the macroscopic length scales.

The introduction of p-adic number fields led to the generalization of the notion of space-time so that it also allowed p-adic regions for various values of p-adic prime. The construction of quantum TGD led after five years of failed attempts using standard

recipes to the idea about physics as a geometry of "world of classical worlds" (WCW): this defines a rather awe inspiring geometrical object. WCW could consist of space-time surfaces representing preferred extremals of certain action and the geometrization of WCW would also provide it with spinor structure - in well-defined sense square root of metric structure. WCW spinor fields (formally purely classical objects) would define the quantum states of the Universe. This vision generalizes the earlier ideas proposed by Wheeler in general relativity context.

### 3 TGD inspired consciousness and ontology

Thanks to the authority of Penrose, the idea of quantum consciousness was getting boost around 1995, and several discussion groups about consciousness flourished around it. My own key idea was that physics must be expanded to a quantum theory of consciousness by bringing the observer - self - as an integral part of the physical system. This forced me to take seriously the basic problem of standard quantum measurement theory caused by the necessity to assume non-deterministic state function reduction, which is in an obvious conflict with the determinism of Schrödinger equation.

The solution to the problem was based on giving up the identification of the experienced time with the geometric time of physicists. This is of course also strongly suggested by the reversibility of geometric time, which is in conflict with the irreversibility of experienced time: here as well the sociology of science has blinded the intellect of physicists. Quantum jumps and state function reductions would occur between entire quantum histories regarded as generalization of time evolutions of Schrödinger equation rather than modifying single time evolution of Schrödinger and in this manner doing violence to the field equations. Also the geometric past would change in quantum jump: as a matter of fact, already Wheeler had intuited that this occurs (delayed choice experiment).

The new view about time is perhaps the most important part of my credo and leads to a rather radical modification of beliefs about how the arrows of geometric time and psychological time emerge from the natural arrow of the subjective time identified as a sequence of quantum jumps.

In order to reproduce standard quantum measurement theory one must assume some variational principle: I christened this principle Negentropy Maximization Principle. NMP becomes the basic variational principle of consciousness. In form it is similar to the second law and it indeed implies second law at the level of ensembles. Its detailed formulation leads to a far reaching generalization of the views about what happens in state function reduction.

### 4 Quantum biology and ontology

The new view about space-time and classical fields inspired the attempts to build up concrete models for biomolecules, living cell, biological body, brain, etc.. The basic challenge is to understand how living matter manages to be a macroscopic quantum system. Here the experimental findings of the pioneers of bio-electromagnetism like Blackman about the effects of ELF em fields on vertebrate brain were a crucial source of inspiration.

After some yers of stumbling around I ended up postulating the existence of a hierarchy of Planck constants coming as multiples of ordinary Planck constants and identifying dark matter as phases of ordinary matter with large Planck constants. Dark matter would be a key player in the physics of living matter.

Later it turned out that there is no necessity to postulate this hierarchy separately: it follows from TGD as an *effective* hierarchy and is essentially due to the very special character of the quantum criticality of TGD Universe forcing so called Kähler action as the unique variational principle. Quantum criticality in turn implies a generalization of conformal symmetries of super string models and that the TGD Universe is a critical system.

Quantum criticality implies that many characteristics possessed by living matter are characteristics of TGD Universe in all scales: maximal complexity and maximal sensitivity to external perturbations, a large number of states with essentially the same energy making it possible to represent the states of external world as internal states, long range correlations giving rise to macroscopic coherent structures, etc..

Many-sheeted space-time leads to a new view about classical fields - even about electromagnetic fields. Topological field quantization is the basic phenomenon. Magnetic fields, electric fields, radiation fields: all these fields are topologically quantized which means that they decompose into quanta represented as space-time sheets. Magnetic flux tubes and flux sheets represent an example of this quantization and the notion of magnetic body consisting of magnetic flux quanta becomes a new ontological level in the description of living matter requiring a rejection of the idea that biology can be reduced to mere chemistry.

The magnetic body could be seen as the intentional agent (more precisely, space-time correlate for it) using biological body as motor instrument and receiving sensory input from biological body. EEG and its variants would make possible the communications needed to achieve this. EEG would have fractally scaled counterparts in a very wide frequency range and scaling up of Planck constant while keeping the energy of EEG photons fixed would mean a downwards scaling of frequencies of EEG.

Magnetic flux tubes carrying dark matter provide a repertoire of mechanisms allowing us to understand how living matter manages to behave like a coherent unit. The secret would be simple: flux tubes connect biomolecules and also larger structures to a kind of Indra's net. Even different organisms could belong to this net so that the entire biosphere would be a gigantic organism. A change in the value of effective Planck constant for a particular flux tube induces a change in the length of the flux tube and this suggests a way in which selected biomolecules can find each other in the dense molecular soup of a cell. Reconnection of magnetic flux tubes would be fundamental for understanding various communications inside organism.

## 5 Summary about what exists

My credo could perhaps be expressed as a list of beliefs about what exists and can be known. My ontology and epistemology are based on the general mathematical structure of quantum TGD.

## 5.1 What exists?

1. The notion of many-sheeted space-time generalized to also include p-adic space-time sheets is the basic geometric element of the ontology. WCW represents the higher level geometric element and WCW spinor fields define the counterparts of quantum states of quantum field theories as purely classical objects. This picture means giving up the view based on quantum field theories (QFTs), of a fixed background space-time assumed to be empty Minkowskian space. Now quantum states are quantum superpositions of space-time surfaces. Under usual conditions one can use QFT as an effective description. The understanding of living matter and consciousness seems however impossible in QFT framework.
2. Giving up the attempts to force subjective and geometric time to wear the same shoe means the introduction of a new ontological level and the relation between these two times continues to be one of the basic challenges of TGD. The new view about time leads to a fresh approach to memory, realization of intentional action and metabolism. The new element are negative energy signals propagating to geometric past and obeying second law but with a reversed direction of geometric time (this means a generalization of second law). Already Fantappie introduced the notion of syntropy based on the observation that living matter exhibits both entropic and syntropic aspects.
3. At the basic level the TGD inspired ontology is tri-partistic. It distinguishes sharply between physical existence and conscious existence. Physical existence one has two basic aspects: physical existence as quantum state on one hand and as the geometry of space-time surface on the other hand. Quantum classical correspondence relates these two levels of physical existence to each other. Both quantum states and space-time surfaces are non-conscious.

Conscious existence corresponds to a sequence of quantum jumps identifiable as selves. Quantum jumps form a fractal hierarchy. The Self experiences its sub-selves as mental images. Consciousness resides in the quantum jump replacing one physical existence with a new one. The key idea is that conscious existence is in the change, something between two physical worlds rather than in physical world. This implies a departure from the materialistic/physicalistic view about brain. Consciousness is not a property of brain state but something between two brain states.

In this ontology it is not necessary to assume a "reality" behind the physical/quantum state. Quantum states can be identified as purely mathematical objects. Conscious experience is created in quantum jumps between these mathematical objects and gives an approximate information about the quantum states themselves. Conscious experience results from hopping around the Platonia populated by these quantum states. This eliminates the problematic reality-theory duality. Replacing the unique objective reality with an entire Platonia of basically geometrical objects means giving up the basic materialistic dogma. Allowing the Platonia also means a deviation from the world view of idealism accepting only the subjective reality.

4. Conscious existence has several aspects such as cognition and sensory experience.

The ontological division between the worlds of thought and sensory experience would correspond at the level of mathematical existence to real-number based physics and p-adic physics for various values of p-adic prime  $p$ . p-Adic physics would provide the physical correlates of cognition and intentionality. Number theoretical entanglement entropy, which can have negative values and a minimum for a unique prime  $p$ , and in this case represents information, is one of the implications. Negentropic entanglement is stable under NMP, and one can assign to negentropic entanglement various positively colored aspects of conscious experience: understanding, love, and other "bonding" experiences...

5. Zero energy ontology (ZEO) has become an important element of TGD. In ordinary quantum physics positive energy ontology (PEO) prevails. PEO states that one can assign to any isolated system a conserved energy which positive. PEO is however problematic. In deterministic classical physics it selects just a single solution of field equations so that the theory becomes in principle completely untestable without additional assumptions, which can hold true only approximately. In quantum theory PEO allows only solutions with fixed conserved quantum numbers so that in principle one still has the same problem. In ZEO quantum states have vanishing total energy and consist of pairs of positive and negative energy states. Any zero energy state is in principle createable from vacuum so that the theory is maximally testable. This also implies that consciousness has maximal causative power: free will can even create even new Universes from vacuum.

## 5.2 What can be known?

This credo should say also something about what can be known: epistemology. Often new theories pose restrictions to what can be known. For instance, quantum mechanism introduced the Uncertainty Principle and Gödel's theorem demonstrated the limitations of axiomatic approach.

In the TGD framework the notion of finite measurement resolution has gradually become one of the guiding principles. In standard QFT this notion is a kind of ugly duckling but taking it seriously leads to a beautiful and extremely intricate mathematics of von Neumann algebras and to so-called quantum groups, which are "known" to be somehow part of future theoretical physics.

One can also speak about finite cognitive resolution. The loss of information is in the optimal situation a loss of irrelevant information. The content of our consciousness is indeed an extremely sketchy representation of reality. Otherwise we would drown in irrelevant information. For instance, self is postulated to experience its sub-selves as mental images and the sub-selves of sub-selves as a kind of averaged contribution. This would give rise to a hierarchy of abstractions necessary for a conscious intelligence.

A second limitation to the conscious information is due to the fact that conscious experience is always about the change: the physical state is replaced by a new one. Certainly the information is very limited: it might be related to the negentropic entanglement stable under state function reduction. A simple guess is that the increments of quantum numbers in quantum jump characterize qualia. In a materialistic vision the conscious information would be equated with the physical state. It is far from clear

that this kind of notion can be defined at all! If this were possible, there would be a huge amount of irrelevant conscious information since we would be conscious of every detail down to Planck length and beyond.