

Time and Consciousness

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Abstract

This chapter as also other chapters about the notion of time appearing in books about TGD inspired theory of consciousness should be taken as stories about how ideas developed through many tortuous twists and turns. In this abstract I only summarize the outcome and leave the description of the tortuous path to the chapter.

If one accepts the identification of moment of consciousness as quantum jump between quantum histories, the basic challenge is to explain how psychological time arises: why the contents of at least sensory experiences are concentrated around definite value of geometric time and what is the origin of the arrow of psychological time. It has become gradually clear that TGD cannot reproduce the common sense conception of time as such and that one can only require that the generalized view is consistent with our restricted conscious experiences and shows our position in the hierarchy of consciousness.

The understanding of the notion of psychological time and its arrow - or equivalently, the relationship between subjective and geometric time - turned out to be quite difficult challenge and led to a handful of proposals based on the identification of space-time sheet as a correlate of self and the idea that the experienced flow of geometric correspond to some kind of motion in space-time or in embedding space. These identifications did not lead to anything practical and generated paradoxes. Also the notion of self turned to be problematic.

The most recent proposal involves no ad hoc assumptions and relies on the recent formulation of quantum TGD using zero energy ontology (ZEO) and the understanding of both nature of time and self reduces to a more precise view about what happens in state function reduction in ZEO.

1. The embedding space correlate of self is so called causal diamond (pair of future and past directed light-cones) which is 8-D sub-manifold of the embedding space rather than space-time sheet.
2. In ZEO state function reduction can occur at both boundaries of CD but can occur repeatedly at given CD boundary. In the repeated reduction the already reduced positive/negative energy state remains the same just as the state function remains invariant in ordinary repeated state function reduction. Second boundary of CD corresponds to a wave function in the moduli space of CDs and changes: since the distance between the tips of CD is one particular modular degree of freedom, the average value of this distance tends to increase just as the distance of particle diffusing inside cone increases during diffusion. This gives rise to the experience flow of geometric time identified this temporal distance.
3. Self can be understood as a sequence of repeated state functions at the same boundary - the original identification was as sequence of all quantum jumps. The arrow of geometric time changes at some level of self hierarchy when quantum jump takes at the second boundary of CD and could correspond to volition, act of free will.
4. The notion of negentropic entanglement also leads to a model for self model to be carefully distinguished from self.

The concept of self led to the understanding of the subjective memory as an average over experiences of self experienced after its “wake-up”. Subjective memories are always about past. Geometric memories are predictions for the future/past assuming that no quantum jumps would occur after/had occurred before the one giving rise to the geometric memory. Pre-cognitions can be seen as geometric memories about future. Intentions are p-adic variants of precognitions. It seems that long term memories must correspond to geometric memories: this hypothesis, when combined with the spin glass model of brain, the notion of quantum self-organization, and some key aspects of many-sheeted physics, allows to understand the basic aspects of the long term memory and avoids the basic difficulties of the neural net models.

1 Introduction

The identification of moments of consciousness as quantum jumps between quantum histories suggests that our common sense picture about the time evolution of universe might be badly misguided by the restrictions posed by the basic features of our conscious experience. What one can do is to try to develop the most general picture about the cosmology of consciousness consistent with our own conscious experiences and try to identify our position in this picture. Already in

its recent form TGD inspired theory of consciousness can give quite restrictive constraints on this Grand Scenario.

The understanding of how psychological time and its arrow emerge has been perhaps the most longstanding problem of quantum TGD and TGD inspired theory of consciousness. By quantum classical correspondence the arrow of subjective time should be mapped to the arrow of geometric time at the level of conscious experience. In similar way the asymmetry between subjective future and past should correspond to an asymmetry between geometric future and past. What this means at the level of details has been far from clear and I have proposed many partial answers to the question about the arrow of geometric time.

For instance: the geometric future inside light-cone contains much more room than geometric past so that the space-time region about which the contents of conscious experience are about tends to diffuse to the direction of the geometric future defined by light-cone proper time; perhaps the flow of geometric time corresponds to a wave front of intentional action identifiable as a phase transition changing intentions identified as p-adic space-time sheets transformed to real space-time sheets; maybe the space-time sheet assignable to self topologically condensed to a larger space-time sheet shifts in quantum jumps to the direction of geometric future some average temporal distance perhaps defined by CP_2 length scale. All these proposals have provided only partial answers, have led to paradoxes, and failed to give a firm quantitative grasp about the situation.

Also the original wrong view about the correspondence of real and p-adic numbers has generated a lot of confusion. The natural belief of topologist would be that p-adic space-time sheets are mapped to their real counterparts by a continuous map (some variant of what I called canonical identification making sense in p-adic thermodynamics). This map did not however respect symmetries and was inconsistent with field equations. Finally I was able to accept the natural belief of algebraist: reals and various p-adic number fields must be glued to together along rationals and common algebraic numbers to achieve generalization of the number concept and also that of embedding space. What was difficult to accept was the highly non-intuitive implication that most points of p-adic space-time sheets are at spatial and temporal infinity in real (but not in p-adic) sense so that cognition and intentionality would be literally cosmic phenomena and only cognitive representations would be realized in a finite space-time volume in real sense (causal diamond) in terms of intersections of real and p-adic space-time sheets consisting of rational and some algebraic points.

The development visions about zero energy ontology (ZEO) and about hierarchy of Planck constants labelling a fractal hierarchy of quantum criticalities and dark matters have been instrumental in developing the recent phenomenology of consciousness and time.

I have tried to tidy up the chapters so that they would not contain too many mammoth bones. Since I can use only a finite amount of time to documentation purposes, I have not been completely successful and this chapter as also others might contain statements which represent earlier archeological strata. I hope that reader could forgive this. Benevolent reader might even take these chapters as documents about how ideas have developed.

1.1 The Concepts Of Self, Time, And Subjective Memory

The notion of self has developed gradually to its recent form. Consider first the original proposal and its evolution before the discovery of zero energy ontology (ZEO).

1. I identified self as a subsystem able to remain unentangled during quantum jumps consisting of unitary processes U defining what I called “informational time evolutions” followed by a state function reduction which in zero energy ontology includes also state preparation occurring for the negative energy part of the state (zero energy state corresponds to physical event in positive energy ontology with negative and positive energy parts of the state being identified as the counterparts of the initial and final states of the event). The obvious counter argument is of course that un-entangled states are not stable.
2. Bound state entanglement is stable against state function reduction so that consciousness would be lost the bound state entanglement is generated. This would stop the sequence of state function reductions initiated after the U -process.

3. The notion of number theoretic entropy allows to assign entanglement negentropy to algebraic entanglement probabilities so that NMP favors the generation of entanglement in this kind of situation. This encourages the hypothesis that subsystem does not lose consciousness if it generates algebraic entanglement with environment. This would correspond to the fusion to the sea of consciousness in the spiritual terminology. Algebraic entanglement is possible in the intersection of real and p-adic worlds which in turn encourages the proposal that living matter corresponds to this intersection, and is therefore a critical phenomenon in number-theoretical sense so that evolution involves in an essential way the generation of algebraic entanglement.

It turned out that consistency with quantum measurement theory requires that density matrix for the reduced state is projector and thus proportional to unit matrix. Unitary entanglement - typically associated with quantum computers - gives rise to projector as density matrix in the case of two entangled systems. This only generalizes the standard quantum measurement theory in that the reduced density matrix can be a higher-dimensional projector.

4. One can say that self is a subsystem behaving like its own sub-Universe (with respect to NMP). What this really means quantitatively is far from obvious.

The precise definition of self however remained a longstanding problem and I have been even ready to identify self with quantum jump. Also the understanding of the relationship between experienced time and geometric time has been a longstanding challenge. Zero energy ontology allows what looks like the final solution of the problems.

1. Self indeed corresponds to a sequence of quantum jumps integrating to single unit, but these quantum jumps correspond to state function reductions to a fixed boundary of CD leaving the corresponding parts of zero energy states invariant. The zero energy state is a superposition of the zero energy states associated with the CDs with only second boundary at fixed light-cone boundary. Hence the distance between the tips of CDs in the superposition varies.
2. In positive energy ontology these repeated state function reductions would have no effect on the state but in TGD framework there occurs a change for the second boundary. This explains how the experience of subjective time and its arrow emerges. The average distance between the tips of CDs increases and self experiences flow of time. These repeated state function reductions correspond to unitary process. Self dies when the first reduction to opposite boundary of CD occurs and creates new self. The lifetime of self is the increase of average distance between the tips of CDs in superposition. The first quantum jump to the opposite boundary corresponds to the act of free will or wake-up of new self. In particle physics time scales this first corresponds to the quantum measurement.

The hypothesis that the experiences of self associated with the quantum jumps occurred after the “wake-up” sum up to single experience, implies that self can have memories about earlier moments of consciousness. Therefore self becomes extended object with respect to subjective time and has a well defined “personal history”. If temporal binding of experiences involves kind of averaging, quantum statistical determinism makes the total experience defined by the heap of the experiences associated with individual quantum jumps reliable. Subjective memory associated with sensory mental images has duration of about .1 seconds from the temporal resolution of sensory experience: it is quite possible that our self has much longer duration. The subjectotemporal sequences of sub-selves make possible to remember the digits of a phone number.

The identification of the fundamental volume of attention as a causal diamond (CD) provides answers to more detailed questions. This identification means also that at the level of embedding space causal diamond of embedding space (or their superposition) serves as the correlate of self whereas at space-time level space-time surface (or their superposition) serves as a correlate of self.

Subsystem X possessing self behaves essentially as a separate sub-Universe with respect to NMP. An attractive hypothesis is that the experience of self is abstraction in the sense that the experiences of sub-selves X_{ij} of X_i are abstracted to average experience $\langle X_{ij} \rangle$. This implies that the experiences of sub-sub-...selves of X are effectively unconscious to X . This self hierarchy is infinite and has entire Universe, God at the top. Temporal binding with averaging implies that experiences of individual selves are reliable and abstraction brings in the possibility of quantum statistical determinism at the level of ensembles.

1.2 Negeentropy Maximization Principle And Ethics

Negeotropic entanglement corresponds to a density matrix, which is higher-dimensional projection operator. Number theoretic entanglement negeentropy for a prime appearing as a factor of the dimension of the density matrix is indeed positive. Negeotropic entanglement could be seen as a quantum physical correlate for love, understanding, and various states of consciousness with positive coloring.

NMP states that the entanglement entropy is reduced in the first state function reduction to the opposite boundary of CD. The subsequent reductions do not change the part of the state at this boundary so that negeentropy is not changed. The negeentropy for sub-CDs associated with the mental images of self can however increase by repeated state function reductions to the opposite boundary of sub-CD.

NMP allows too variants.

1. The strong variant of NMP implies that entanglement entropy of the state at opposite boundary of CD is not only reduced in state function reduction but also the entanglement negeentropy of the resulting state at opposite boundary of CD cannot be lower than it was at original boundary of CD. One can wonder whether this leaves any free will and whether only good deeds, which would not be deeds since no selection is involved, are possible.
2. Second variant of NMP allows reduction to any sub-space of the space defined by a projection matrix appearing in the density matrix. Self can thus choose between good and evil. In this case, entanglement entropy would be always reduced in state function reduction but the entanglement negeentropy of the state at the opposite boundary of CD need not be higher than that at the original boundary.

In religious view these options correspond to God which allows only good deeds and to God that allows the sinner to choose between Evil and Good.

1.3 Cosmology Of Consciousness

The idea about cosmology of consciousness is inspired by the prediction of the infinite self hierarchy and by quantum-classical correspondence principle [K19]. The expectation is that the fractal structure of the many-sheeted space-time should directly reflect the general structure for the cosmology of consciousness. For instance, the p-adic evolution of consciousness should have its counterpart at the space-time level. Indeed, there are good reasons to believe that 4-surfaces have decomposition into real regions and p-adic regions and that one can assign to each real region a finite prime p characterizing the effective p-adic topology of the real space-time region (or of light-like 3-surface or partonic 2-surface) and the p-adic topology which the real region is near criticality to transform to. In zero energy ontology this transformation indeed makes sense. Just like configuration space is conjectured to have a decomposition into regions D_P labelled by infinite p-adic primes P , the space-time surface decomposes into real regions labelled by finite primes appearing in the decomposition of P .

Fractality suggests that there are conscious universes within conscious universes and the nested structure of the topological condensate suggests that experiences of universes involve kind of abstractions about the experiences of the sub-universes they contain. The prediction of infinite hierarchy of selves and summation hypothesis for the experiences of selves is in accordance with this expectation.

Mind-like space-time sheets were introduced originally as space-time sheets of finite temporal duration or alternatively as space-time sheets for which the classical determinism in the standard sense of the word fails. In zero energy ontology all space-time sheets have finite temporal scale and zero energy states associated with them have mind-like aspects. For instance, the positive and negative energy parts of the fermionic state define a quantum representation for an abstraction for the Boolean statement $A \rightarrow B$ with various instances of a and b appearing in the superposition.

Since mind like space-time sheets have a bounded time duration, one cannot assign to a quantum jump a single value of the geometric time. Rather, our psychological time would be associated with one of the infinitely many irreducible sub-experiences associated with mind like space-time sheets

and the values of the psychological time range from zero to infinity. Since selves contain sub-selves with various values of psychological time, experiences are actually multitime experiences with respect to both geometric and subjective time. The entire 4-dimensional space-time is a living system: both the geometric future and past are living and participate in each moment of consciousness. Selves have increasingly longer geometric and subjective memories and that at the limit of entire universe selves have infinitely long subjective memory.

1.4 Four-Dimensional Brain

The hypothesis that entire space-time surface is populated by mind like space-time sheets realized in concrete way in zero energy ontology in terms of causal diamonds (CDs) representing systems participating in every moment of consciousness, means also dramatically new way to understand brain. For instance, the problem of memory trivializes. Geometric memory provides simulations and expectations for what happened and will happen whereas subjective memory has interpretation as immediate short term memory. The most plausible interpretation of long term memories is as geometric memories represented by multitime snapshots. This hypothesis explains the practically unlimited capacity of autobiographical memory and also other basic aspects of long term memories and avoids the counter arguments against the neural net models of long term memory.

The paradigm of four-dimensional brain (and body!) forces to reconsider the basic dogma of neuroscience stating that sensory consciousness is associated with brain only and explains nicely the results of Libet's experiments. A concrete model of the long term memory is based on quantum mirror mechanism: experience long term memory means looking at a quantum mirror at a distance of say light years. The attribute "quantum" means that there is no need to code information to a classical signal, just time like entanglement made possible by the classical nondeterminism of Kähler action and by p-adic nondeterminism is enough.

In ZEO self-organization is 4-D. It is 4-D pattern (time evolution of say magnetic body) which evolves quantum jump by quantum jump to the asymptotic pattern. This has profound implications for understanding of say morphogenesis and emergence of behavioral patterns.

1.5 Evidence For TGD Based Time Concept

The new concept of time follows from the quantum jump between quantum histories concept so that tests for the latter are indirect tests for the former. Perhaps the strongest support for the new concept of time comes from the requirement of the internal consistency of the world view. The phenomenon of dissipation is paradoxical from the point of view of standard physics. It is generally accepted that fundamental laws of classical physics are reversible whereas everyday reality is manifestly irreversible. Thus the situation is rather schizophrenic. Two worlds, the reversible and extremely beautiful world of fundamental physics and the irreversible and mathematically rather ugly, irreversible "real" world, seem to exist simultaneously. Quantum jumps between quantum histories concept solves the paradox and one can understand dissipative world as an effective description forming "almost" envelope for the sequence of reversible worlds understood as entire time evolutions.

Quantum jumps between quantum histories concept explains the peculiar time delays of consciousness revealed in the experiments of Libet and Kornhuber relating to active and passive roles of consciousness [J14, J6] and the causal anomalies revealed by the experiments of Radin and Bierman [J7, J8, J12]. TGD predicts "tribar effect" as a general signature for the quantum jump between quantum histories concept.

A further implication is quantum theory of self-organization. Self-organization means the organization of selves leading to fixed point patterns analogous to those generated in Benard flow. This means that dissipation serves as a Darwinian selector of both genes and memes. Dissipation is present also at the elementary particle level and leads to the selection of the p-adic effective topologies of elementary particle space-time sheets. Black-hole elementary particle analogy suggests that the allowed p-adic primes are given the p-adic length scale hypothesis $p \simeq 2^k$, k power of prime.

ZEO brings in an even more radical new aspect. What evolves in quantum self-organization is not a superposition of 3-surfaces but a superposition of 4-D time evolutions represented by preferred extremals of Kähler action connecting two space-like 3-surfaces at the opposite boundaries

of CD evolves. These space-time surfaces represent 4-D patterns, behaviours rather than 3-D states of say brain. Entire quantum history of space-time approaches in self-organization to an asymptotic quantum history. This view has very powerful implications - consider only the modelling of morphogenesis and learning.

A further new aspect of self-organization relates to the hierarchy of Planck constants and NMP. The basic prediction is that the value of Planck constant $h_{eff} = n \times h$ labelling an infinite hierarchy of critical systems tends to increase spontaneously (criticality is reduced as some conformal gauge degrees of freedom having conformal structure become physical), and that living systems tend to stay at criticality (homeostasis and metabolism) and therefore oppose this process. One can indeed understand this in terms of NMP.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. Pdf representation of same files serving as a kind of glossary can be found at <http://tgdtheory.fi/tgdglossary.pdf> [?].

2 TGD Based Concept Of Time

TGD based notion of time involves several new aspects.

1. Quantum jump as occurring between entire quantum histories rather than time=constant snapshots of a single history is certainly the most decisive new element. The necessity to differentiate between subjective and geometric time is immediate implication of this identification.

The basic challenges could be formulated as questions. What is the precise identification of self and how does self relate to quantum jump? How does the experienced flow of time emerge? How does this flow correlate with the increase of the value of geometric time around which the contents of consciousness experiences are located? How the arrow of time emerges?

2. The classical non-determinism of Kähler action is a fundamental ingredient: without it time would be lost in the sense that the contents of our conscious experience would not be localized with respect to geometric time and one could not understand the emergence of psychological time and its arrow. Non-determinism leads to the notions of ZEO (ZEO) and causal diamond (CD) defining the embedding space correlate of self.
3. As discussed in the introduction, ZEO eventually led to the identification of self as a sequence of state function reductions to a fixed (call it passive) boundary of causal diamond (CD) and leave the part of zero energy state at it unchanged.

- (a) In standard quantum measurement theory the repeated state function reductions have no effect on the quantum state. In ZEO the boundary of CD at which reductions take place (call it active) can change. This occurs in elementary particle time scales in every quantum measurement and the sequences of state function reductions at passive boundary are short. In ZEO they the sequences of state function reductions to a fixed boundary give rise to the experienced flow of time and self.

- (b) The experienced flow of time corresponds to the increase of the average distance between the tips of CDs appearing in quantum superposition of CDs. The arrow of subjective time can correspond to both directions of geometric time and changes when the first quantum jump to the opposite boundary of CD - eventually forced by NMP to occur - takes place.

Self dies when a reduction to the opposite boundary of CD eventually forced by Negentropy Maximization Principle (NMP) occurs and creates new self at it.

- (c) A further new element is related to the change of the arrow of geometric time occurring when the first state function reduction to the opposite boundary of CD occurs and induces a dramatic change of the state. The interpretation is as an act of volition. The change of the arrow of geometric time makes also possible classical communications with geometric past, which leads to a new view about memory. The new view about time leads also to the notion of four-dimensional brain implying a new manner to see

what long term memories are, and the vision about space-time as a four-dimensional organism.

- (d) CD serves as embedding space correlate of self - kind of 4-D perceptive field - and space-time surface inside CD as space-time correlate of consciousness. Our conscious experience is about 4-D space-region - or rather about changes in the superposition of these region occurring during repeated reductions at the passive boundary of CD. Naturally the change occurs at active boundary of CD whereas the passive boundary remains unchanged and corresponds to system remaining un-entangled as long as self “lives”.

4. TGD Universe is postulated to be quantum critical. Classical non-determinism leads to the realization of quantum criticality of TGD Universe as an infinite hierarchy of critical systems labelled by the values of Planck constant $h_{eff} = n \times h$. TGD Universe is like a hill at the top of hill at the top of hill... The increase of Planck constant corresponds to a reduction of criticality and tends to occur spontaneously: it is however governed by NMP.

Living systems can be seen as systems trying to stay at criticality (homeostasis and metabolism). During single sequence of reductions at passive boundary of CD its CD size would increase linearly by integer shifts but neither h_{eff} nor negentropic entanglement in the scale of CD would increase.

The flow of time defined by the sequence of the first reductions at opposite boundary of CD would naturally correspond to average increase of h_{eff} and by NMP generation of or at least possibility of generation of negentropic entanglement. This depends on whether NMP only allows reduction to a higher- than 1- dimensional space assignable to the projector part appearing in the density matrix or whether NMP forces. My personal experiences about real world suggests that the first option is more realistic. This does not however mean that wisdom can be gained only by dying. The values of h_{eff} of sub-CDs associated with mental images would increase and mental images of self would get wiser and this could postpone the first state function reduction at the opposite boundary of CD for self.

This view looks like the exact opposite of the standard view inspired by second law but is not in conflict with it since the two notions of negentropy are different.

2.1 The Three Non-Determinisms

TGD Universe is characterized by a “holy trinity” of non-determinisms. The first non-determinism is associated with quantum jumps between quantum histories and is what makes possible subjective existence and consciousness. One achieve determinism by giving up the assumption that initial values at fixed time define the time evolution and replaces 3-dimensional sections of space-time surface with what I have called “mind-like” space-time sheets. The attempt to realize this picture geometrically led to zero energy ontology. Second non-determinism is classical non-determinism of Kähler action and is to symbolic representations and perhaps also with macroscopic volition. The third non-determinism is inherent to all p-adic field equations and might correspond to the non-determinism of imagination and thus makes possible cognition and intentionality. There is no conscious experience associated with classical nor with p-adic non-determinism as dualist might think. These three non-determinisms have turned out to be basic building bricks of TGD inspired theory of consciousness.

The original identification of the geometric correlates of selves was as mind like space-time sheets. In ZEO all real space-time sheets satisfy the criterion for “mind-likeness” and therefore serve as correlates for selves. Therefore the notion of “mind-likeness” becomes redundant.

2.2 Some Aspects Of Classical Non-Determinism

The general view about the classical non-determinism of Kähler action and its role in TGD and TGD inspired theory of consciousness has developed gradually and still does so. The newest developments relate to the application of quantum gravitational hologram principle in TGD framework. What has been however clear for a long time is that TGD inspired theory of consciousness falls or stands with the classical non-determinism.

2.2.1 Vacuum extremals

Any 4-surface which belongs to $M_+^4 \times Y^2$, where Y^2 is so called Legendre manifold of CP_2 representable as

$$P_i = \nabla_i f(Q_1, Q_2), \quad i = 1, 2 \quad ,$$

where f is arbitrary function and (P_i, Q_i) are some canonical coordinates of CP_2 , is vacuum extremal of Kähler action. For these vacuum extremals the signature of the induced metric can be either Minkowskian or Euclidian. There are also vacuum extremals with Euclidian signature of the induced metric. The so called CP_2 type vacuum extremals have light like random curve as light cone projection. These extremals are isometric with CP_2 so that the signature of the induced metric is Euclidian. These extremals provide a model for elementary particle.

Only the non-vacuum deformations of the vacuum extremals are physical. The remnants of the huge vacuum non-determinism are expected to give rise to the non-determinism required by symbolic representations of conscious experience at the level of space-time dynamics giving rise to language as a special case. Of course, classical nondeterminism of the Kähler action might also relate to the nondeterminism of volition. It seems that the CP_2 type extremals representing cognitive neutrino pairs are crucial for our cognitive consciousness and its transformation to symbolic representations.

2.2.2 “Mind-like” space-time sheets as deformations of vacuum extremals

The original proposal that “mind-like” space-time sheets and “matter-like” space-time sheets differ in the sense that the first ones are non-deterministic and consist of a collection of 3-surfaces with time-like separations whereas the latter are deterministic or at least have infinite size in time direction by standard conservation laws. In zero energy ontology “mind-like”ness in this sense holds true quite generally.

Physical intuition suggests that the gluing vacuum extremals to a material space-time sheet $X^3(Y^3)$ by $\#$ (topological sum) contacts, an interaction results and deforms vacuum extremal slightly and that in some cases this leads to a new preferred extremal with a slightly larger value of Kähler function and hence a larger value of the vacuum functional making the 3-surface more probable. These deformed vacuum extremals are expected to be still non-deterministic although the non-determinism should be reduced considerably. Via their interactions with the environment, (“mind-like”) space-time sheets provide sensory and symbolic representations for some aspects of the surrounding world. Hence they are quite generally natural geometric counterparts of selves. For instance, the time evolution of our body would correspond to this kind of deformed vacuum space-time sheet with a finite time duration. The space-time surfaces $X_i^4(Y^3)$ are expected to be very nearly identical outside the time-interval characterizing the size of the mind like space-time sheet: this in turn implies time localization for the non-determinism of quantum jump and therefore for the contents of conscious experiences associated with the mind like space-time sheet.

In ZEO “mind-like” space-times sheets correspond to a collection of 3-surfaces belonging to boundaries of causal diamond (CD) and its sub-CDs corresponding to the classical correlate for radiative corrections. Generalized causality makes it possible to avoid paradoxical situation: assuming that space-time surface $X^4(Y^3)$ is preferred extremal of the Kähler action for Y^3 one might always find a new 4-surface giving rise to a smaller Kähler action by gluing suitable vacuum extremal to $X^4(Y^3)$.

2.2.3 Massless extremals as quantum gravitational holograms

Massless extremals (MEs) belong to the fundamental solutions of field equations. It has become also clear that they play the role of quantum gravitational holograms. The hologram principle of quantum gravitational theories roughly states that the quantum theory in space-time with boundary reduces to a conformal quantum field theory at the boundary. If Kähler action were deterministic, precisely this would happen. The construction of WCW geometry relies crucially on the assumption that the complications due to the non-determinism of Kähler action does not radically modify the construction based on the assumption of a complete determinism.

It has indeed turned out that the basic construction in which everything reduces to the light like boundary of M_+^4 (moment of big bang) acting as a hologram in quantum gravitational sense and defining conformal quantum theory, generalizes. This construction survives as a template in a more general construction in which also the light like boundaries of MEs having always light like M_+^4 projection are taken into account besides δM_+^4 as surfaces at which initial values can be fixed arbitrarily. This brings in also time absent in a strictly deterministic theory. Thus the quantum gravitational hologram defined by δM_+^4 is replaced by a fractal structure formed by δM_+^4 and Russian doll hierarchy of the light like boundaries of MEs inside MEs. The super-canonical and super-conformal invariances of the light like boundaries indeed generalize in an elegant manner thanks to the basic properties of MEs.

The “light like selves” defined by the boundaries of MEs could be fundamental in TGD inspired theory of consciousness. The super-symplectic quantum states associated with these boundaries are genuine quantum gravitational states defined by WCW functionals, whose dependence on the bosonic fiber degrees of freedom of WCW does not reduce to a mere vacuum functional given by the exponent of Kähler action. This means that these states do not possess any quantum field theoretic counterparts. They are state functionals in the world of worlds (WCW), so to say, and therefore should represent highest level in the hierarchy of quantum control in living systems. Thus it is the higher abstraction level of quantum gravitational states which connects conscious intelligence and quantum gravitation.

2.3 Quantum Jump As Moment Of Consciousness

Quantum jump between quantum histories identified as moment of consciousness was originally believed to be something irreducible and structureless. Gradually the view about quantum jump has however become more and more structured and a connection with the standard quantum measurement theory emerged. In what sense quantum jumps remains irreducible is that one cannot build any dynamical model for the non-deterministic steps appearing in quantum jump.

2.3.1 The general structure of quantum jump

It seems that TGD involves “holy trinity” of dynamics.

1. The dynamics defined by the preferred extremals of Kähler action corresponds to the dynamics of material existence, with matter defined as “res extensa”, 3-surfaces. What preferred extremals really are has been a long standing open question. The recent formulation of the quantum theory using Kähler-Dirac action leads to the proposal that the preferred extremals are critical in the sense that they allow an infinite number of deformations for which the second variation vanishes. At the level of Kähler action this corresponds to the vanishing of classical Noether charges for a sub-algebra of super-symplectic algebra isomorphic with the entire algebra. This serves as space-time counterpart for quantum criticality of TGD Universe fixing the fundamental variational principle uniquely.
2. The dynamics defined by the sequence of state function reductions at fixed boundary of CD defining the life span of self at given level of hierarchy. This time evolution is a discrete counterpart of the ordinary Schrödinger time evolution $U \equiv U(-t, \cdot)$, $t \rightarrow \infty$ and can be regarded as “informational” time development occurring at the level of objective existence. It is un-necessary and in fact impossible to assign real Schrödinger time evolution with U . U defines the S-matrix of the theory. These reductions define the dynamics of sensory perception (passive aspects of consciousness) during which external world is regarded as unchanged in standard framework. Now the part of zero energy state at the fixed boundary of CD remains unchanged and un-entangled.
3. The dynamics of state function reductions at opposite boundary of CD defines the dynamics of volition (active aspects of consciousness).

Quantum jump was originally regarded as something totally irreducible. Gradually the structure of the complex formed by state function reductions and unitary process has revealed itself and led to the understanding how one can understand basic aspects of conscious experience in terms of this structure. Let us start with the original picture.

1. The first step in quantum jump was identified as “informational time development”

$$\Psi_i \rightarrow U\Psi_i ,$$

where U is the counterpart of the unitary process of Penrose. The resulting state is a completely entangled multiverse state, the entire sub-universe corresponding to a given CD being in a holistic state of “oneness”.

In the recent picture Universe is replaced with CD and “informational time development” corresponds to a sequence of state function reductions keeping second boundary of CD and states associated with it fixed. Repeated measurement having no effect on quantum state is the analog in standard quantum measurement theory. Self corresponds to this sequence.

Two subsequent reductions at same boundary of CD have unitary process between them tending to increase the size CD. The challenge is to identify the unitary process U . Self experiences the flow of time, which suggests that the unitary operator followed by localization in the moduli spaces of CDs corresponds to an integer shift for the tip of the active boundary of CD. No state function reduction can occur at the active boundary of CD during this period.

2. Next comes the TGD counterpart of state function in the ordinary sense of the word:

$$U\Psi_i \rightarrow \Psi_f^0 .$$

According to the recent view, the state function reduction in this sense corresponds to the state function at the opposite boundary of cD and leads to a change of the arrow of geometric time. Old self dies and new self is born. In this transition also the value of h_{eff} is expected to increase. This reduction is preceded by a scaling of by the integer ratio $h_{eff}(f)/h_{eff}(i)$ and realized as a unitary exponential of conformal scaling operator. Thus both Poincare and conformal time developments are realized.

3. The state function reduction for given CD is followed by a cascade of self measurements for sub-CDs in quantum fluctuating degrees of freedom

$$\Psi_f^0 \rightarrow \dots \rightarrow \Psi_f ,$$

whose dynamics is governed by the Negentropy Maximization Principle (NMP). For a generic entanglement probabilities this process leads to bound states or negentropically entangled states. This process can be regarded as an analysis or even decay process. If entanglement probabilities define projection operator, the state function reduction leads or can lead to a negentropically entangled state: this depends on what form of NMP one assumes. Entanglement coefficients correspond to unitary matrix in this case.

Quantum measurement theory involves also the correlation between quantum degrees of freedom and classical degrees of freedom (the position of the pointer of the measurement apparatus correlates with the outcome of the measurement).

1. The assumption that localization occurs in zero modes of the WCW would pose very important consistency condition: there is one-one correlation between the quantum numbers in quantum fluctuating degrees of freedom in some state basis and the values of the zero modes. This in fact has interpretation in terms of holography: classical degrees of freedom in space-time interior correlate with fermionic degrees of freedom assignable to string world sheets and partonic 2-surfaces. This together with the fact that zero modes are effectively classical variables, implies that the localization in zero modes corresponds to a state function reduction.
2. Measurement theory requires an entanglement between zero modes and quantum jumps of the physical state. The addition of a measurement interaction term to the Kähler-Dirac action coupling to four-momentum and color quantum numbers of the state and also to

more general conserved quantum numbers allows an explicit realization of this coupling and induces the addition of an analogous measurement interaction term to Kähler action [K34]. This term implies the entanglement of the quantum numbers of the physical states with zero modes.

A good metaphor for quantum jump is as Djinn leaving the bottle (informational time development), fulfilling the wish (quantum jump involving choice) and returning to, possibly new, bottle (localization in zero modes and subsequent state preparation process). One could formally regard each quantum jump as a quantum computation with duration defined by the life-time of corresponding self (the increase of the average temporal distance between the tips of CD in superposition of CDs) followed by halting meaning reduction to the opposite boundary of CD. Quantum jump to the opposite boundary could also be seen as an act of volition (or giving rise to experience of volition at some level of self hierarchy).

2.3.2 Is the complete localization in zero modes really necessary?

The detailed inspection of what happens in state function reductions forces to consider the possibility that state function reduction involves always a complete localization in zero modes. This was indeed the original proposal. It however seems that a localization modulo finite measurement resolution might be a more realistic assumption. Certainly it is enough to explain why the perceived Universe looks classical.

1. QFT picture strongly suggests that sub-system must be defined as a tensor factor of the space of WCW spinors at given point Y^3 of WCW. This suggests that subsystem should be defined as a function of Y^3 and should be a local concept. An important consequence of this definition is that entanglement entropy gives information about space-time geometry.
2. WCW spinor field can be formally expressed as superposition of quantum states localized into the reduced configuration space consisting of 3-surfaces belonging to light cone boundary. Hence WCW spinor field can be formally written as

$$\sum_{Y^3} C(Y^3)(n, N)|n\rangle|N\rangle$$

for any subsystem-complement decomposition defined in Y^3 . Clearly, WCW coordinates appear in the role of additional indices with respect to which entanglement coefficients are diagonal. The requirement that final state is pure state would suggest that quantum jump reducing entanglement must involve complete localization of the WCW spinor field to some Y^3 plus further quantum jump reducing entanglement in Y^3 . Complete localization in WCW is however not physically acceptable option since the action of various gauge symmetries on quantum states does not commute with the complete localization operation. In particular, the requirement that physical states belong to the representations of Super Virasoro and super-symplectic algebras, is not consistent with this requirement.

3. WCW has fiber space structure. WCW metric is non-vanishing only in the fiber degrees of freedom and since the propagator for small fluctuations equals to the contravariant metric, fiber degrees of freedom correspond to genuine quantum fluctuations. WCW metric vanishes in zero modes, which can be identified as fundamental order parameters in the spirit of Haken's theory of self organization. The requirement that various local symmetries act as gauge symmetries, provides good reasons to expect that *entanglement coefficients in the fiber degrees of freedom are gauge invariants and depend on the zero modes parametrically*. The one-one correlation between quantum numbers of the state assignable to fiber degrees of freedom and classical variables identified as zero modes would encourage the assumption the a complete localization occurs in zero modes. A weaker condition is that localization occurs only modulo a finite measurement resolution.
4. The original argument was that the non-existence of metric based volume element in zero modes forces the wave functions in zero modes to have a discrete locus. There however exists a symplectic measure defined by the symplectic form in zero modes. It does not

however allow a complexification to Kähler form as it does in quantum fluctuating degrees of freedom. This symplectic form could define a hierarchy of integration measures coming as restrictions of $J \wedge J \dots \wedge J$ with n factors to $2n$ -dimensional sub-manifolds. Under some additional conditions- maybe the homological non-triviality of J and the orientability of the sub-manifold are enough, this measure would define a positive definite inner product and one would have a hierarchy finite-dimensional sub-spaces of zero modes. The maxima of Kähler function with respect to zero modes replace naturally the continuum with a discrete set of points and define the counterpart of the spin glass energy landscape consisting of the minima of free energy. Effective finite-dimensionality and even effective discreteness would be achieved.

5. The time development by quantum jumps in zero modes is effectively classical: Universe is apparently hopping around in the space of the zero modes. This looks very attractive physically since zero modes characterize the size, shape and classical Kähler fields associated with 3-surface. Therefore each quantum jump gives very precise conscious geometric information about space-time geometry and about WCW in zero modes. This also means that Haken's classical theory of self-organization generalizes almost as such to TGD context. The probability for localization to given point of zero mode space is given by the reduced probability density Q defined by the integral of the probability density R defined by WCW spinor field over fiber degrees of freedom. The local maxima of Q with respect to zero modes appear as attractors for the time development by quantum jumps. Dissipative time development could be regarded as a sequence of quantum jumps leading to this kind of local maximum.
6. Effective localization in zero modes is completely analogous to spontaneous symmetry breaking in which scalar field attains vacuum expectation value with the difference that the number of degrees of freedom is infinite unlike in typical models of symmetry breaking. Thus the general structure of the WCW spinor field together with TGD based quantum jump concept automatically implies spontaneous symmetry breaking in its TGD version (note however that particle massivation results from both p-adic thermodynamics and coupling to Higgs like field of purely geometric origin in TGD framework). TGD Universe is superposition of parallel classical universes (3-surfaces). Therefore quantum entangled state can be regarded as a superposition of parallel entangled states, one for each 3-surface. Formally entanglement coefficients can be regarded as coefficients containing the WCW coordinates of 3-surfaces as additional index. The analogy with the spin glass also supports the localization in the zero modes.
7. Effective localization in the zero modes provides simple explanation for why the universe of conscious experience looks classical: moment of consciousness makes it classical. It also explains why the physics treating space-time as a fixed arena of dynamics has been so successful. As already found, a further important consequence is first principle description of the state function reduction.

2.4 The Notion Of Self

Self is by definition a sub-system able to remain unentangled in subsequent quantum jumps. The original belief was that this characterizes the notion of self completely. Only bound state entanglement is stable in quantum jump and selves correspond to regions of the space-time surface having local topology in a given number field (real or p-adic number fields labelled by primes).

Originally p-adic regions were interpreted as physical (non-conscious) correlates for imagination and cognition whereas real regions correspond to matter and sensory perception. The original belief was that the transformation of p-adic space-time sheets to real ones in quantum jump would correspond to the realization of intention as action. It is now clear that this hypothesis is both unnecessary and difficult to realize mathematically. Rather, TGD Universe is adelic meaning that both embedding space, space-time, and WCW are adelic structure containing real sector and various p-adic sectors as correlates of cognition.

The unitary operator U could in principle generate entanglement also between p-adic and real regions (rational entanglement coefficients make sense in any number field), which is destroyed in the state function reduction step. This might be crucial for the generation of cognitive maps

assigning to the states of matter (say reading of physical measurement apparatus) cognitive states (say mental image about the reading of the measurement apparatus). In the intersection of realities and p-adicities it how does not make sense to distinguish between p-adic and real and the recent view is that string world sheets carrying fermions serving as correlates of Boolean cognition are in this intersection consisting of string world sheets for which the parameters of equations defining them are in some algebraic extension of rationals. One cannot speak about real and p-adic fermions - just fermions.

2.4.1 Assumptions about the structure of conscious experience of self

One makes some structural assumptions about the contents of consciousness of self.

1. The contents of consciousness of self are determined as the average over the quantum jumps occurred after it was created (the real or p-adic space-time region corresponding to self appeared in quantum jump). Selves can have sub-selves and self experiences them as mental images. Self can represent a mental image of a higher level self. Self experiences only the average of its sub-sub-selves. Thus statistical averaging is involved in both subjecto-temporal sense and spatially and is of central importance in the theory of qualia. This suggests that the foundations of, not only quantum measurement theory, but also statistical physics, reduce to the theory of consciousness. Quantum entanglement between sub-selves means fusion of mental images. The simplest assumption is that entangling self loses its consciousness.
2. The sharing of mental images by quantum entanglement is purely TGD based prediction. What happens is rather paradoxical: the sub-selves of unentangled selves bound state entangle so that the resulting fused mental image is shared by both selves. This is not possible if one applies the standard notion of quantum mechanical sub-system as a tensor factor. The p-adic hierarchy of space-time sheets forces to generalize the notion of sub-system (note that also real space-time sheets are characterized by p-adic prime determining the size scale).

Smaller space-time sheets glued to larger space-time sheets are glued to it by wormhole contacts having size of order CP_2 length and having Euclidian signature of the induced metric. This implies the presence of elementary particle horizons at which metric around wormhole contacts changes its signature from Minkowskian to Euclidian. At these 3-dimensional surfaces the induced metric is degenerate so that these surfaces are effectively 2-dimensional and allow conformal invariance crucial for the construction of the quantum theory. The analogy with black hole horizon is obvious.

This allows a situation in which two systems correspond to disjoint surfaces but smaller space-time sheets glued to them are connected by magnetic flux tubes serving as correlates for entanglement. Therefore intuitively selves entangled in given length scale can have sub-selves, which are entangled.

3. Thus many-sheeted space-time and the notion of length scale resolution forces to postulate a hierarchy of systems labelled by p-adic primes and to allow entanglement between sub-systems of unentangled systems. In terms of length scale thinking of quantum field theories, one can say that the entanglement between sub-systems is not visible in the p-adic length and time scales of the systems themselves.

The mathematical description for this length scale dependent view about sub-systems relies on inclusions of hyper-finite factors of type II_1 (HFFs) [K33].

2.4.2 The notion of length scale resolution and self

The rough definition of self is as a subsystem able to remain unentangled during sequential quantum jumps. Self would lose consciousness when it entangles. What this statement really means is far from obvious and I have proposed several interpretations. the following picture represents the recent views.

1. The idea that even slightest entanglement leads to a loss of consciousness does not sound realistic. This suggests that entanglement should be defined only modulo finite measurement resolution. System would be conscious only provided that its entanglement entropy with the

external world is below the value defined by the measurement resolution. For hyper-finite factors of type II_1 the notion of finite measurement resolution is unavoidable. The concrete interpretation at space-time level would be that space-time sheets (sub-selves) topologically condensed at larger space-time sheets (selves) can be connected by flux tubes to form an entangled state. The selves represented by the larger space-time sheets would remain unentangled in the resolution applying to the systems themselves (flux tubes would be invisible in this resolution). This invisible entanglement would however give rise to a sharing and fusion of mental images implying what might be called stereo consciousness.

2. How the notion measurement resolution should be defined is far from obvious. p-Adication approach suggests that finite measurement resolution boils down to a binary cutoff for the p-adic entanglement entropy represented as a series in powers of p . This binary cutoff should have also space-time correlate. For hyper-finite factors of type II_1 and type III_1 emerging naturally in quantum TGD entanglement entropy is always defined only modulo finite measurement resolution, which can be characterized in terms of inclusions of hyper-finite factors [K33]. The included factor defines the measurement resolution in the sense that its action creates states not distinguishable from the original in the resolution used. There should exist a connection between the two approaches.
3. A further complication is due to the fact that also the p-adic variants of Shannon entropy obtained by replacing the logarithm of probability with the logarithm of the p-adic norm of probability make sense if entanglement probabilities are rational or have values in some algebraic extension of rationals. The fact that number theoretic entanglement entropy can be negative is especially attractive from the point of view of consciousness theory and also quantum computation since entanglement indeed carries information. There is also a temptation to identify evolution as the emergence of increasingly complex systems having negative entanglement entropy. The generation of negative entanglement entropy might correspond to a kind of enlightenment experience - fusion to a sea of consciousness - instead of a loss of consciousness.
4. This forces to reconsider the original vision that everything is conscious but consciousness can be lost as the system entangles in U process. U process generates highly entangled states and the sub-sequent state function reduction (possibly modulo measurement resolution) repeatedly decomposes the Universe (or CD) into unentangled pairs of subsystems. The process stops for any subsystem for which all subsystem pairs have either bound state entanglement or negentropic entanglement (see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig. ??** in the appendix of this book). If the bound state entanglement is entropic, the entangled subsystems lose consciousness. If the entanglement between the subsystems is negentropic the process stops but subsystems remain conscious. Mystics might associate the entropic entanglement to what they call attachment and negentropic entanglement to a relationship which they might characterize as love.

2.4.3 NMP and self

2.4.4 NMP and self

The development of the view about Negentropy Maximization Principle (NMP) [K19] has meant also development of the notion of self.

- (a) The original formulation of NMP was in positive energy ontology and made same predictions as standard quantum measurement theory. The only new element was that the density matrix of sub-system defines a fundamental observable and the system goes to its eigenstate in state function reduction.
- (b) p-Adic physics led to the realization that for rational and even algebraic entanglement probabilities it is possible to define number theoretic entanglement negentropy satisfying the same basic axioms as the ordinary Shannon entropy but having negative values and therefore having interpretation as information. NMP would force the generation of

negentropic entanglement and stabilize it. Negentropic entanglement resources of the Universe - one might call them Akashic records- would steadily increase.

- (c) It turned out that the consistency with the quantum measurement theory demands that the density matrix for the final state is projector as also in the standard quantum measurement theory but can project also to a higher-dimensional space. This additional condition allows also to identify negentropic entanglement uniquely: without this restriction one could not really say whether this is the case since rationals form dense set of reals.
- (d) The next step was to realize that this form of NMP is not realistic. NMP would force the Universe to be the best possible one, and this does not seem to be the case. Also ethically responsible free will would be very restricted since self would be forced always to do the best deed that is increase maximally the negentropy serving as information resources of the Universe. This led to the notion of weak form of NMP. Instead of maximal negentropy corresponding to n -dimensional projector self can choose also lower-dimensional sub-spaces and 1-D sub-space corresponds to the vanishing entanglement and negentropy assumed in standard quantum measurement theory.

Weak form of NMP suggests how to understand the notions of Good and Evil. Various choices in the state function reduction correspond to Boolean algebra, which suggests an interpretation in terms of what might be called emotional intelligence [K31]. Also it turns out that one can understand how p-adic length scale hypothesis - actually its generalization - emerges from NMOP [K32].

- (a) One can start from ordinary quantum entanglement. It corresponds to a superposition of pairs of states. Second state corresponds to the internal state of the self and second state to a state of external world or biological body of self. In negentropic quantum entanglement each is replaced with a pair of sub-spaces of state spaces of self and external world. The dimension of the sub-space depends on the which pair is in question. In state function reduction one of these pairs is selected and deed is done. How to make some of these deeds good and some bad?
- (b) Obviously the value of $h_{eff}/h = n$ gives the criterion in the case that weak form of NMP holds true. Recall that weak form of NMP allows only the possibility to generate negentropic entanglement but does not force it. NMP is like God allowing the possibility to do good but not forcing good deeds.

Self can choose any sub-space of the subspace defined by n -dimensional projector and 1-D subspace corresponds to the standard quantum measurement. For $n = 1$ the state function reduction leads to vanishing negentropy, and separation of self and the target of the action. Negentropy does not increase in this action and self is isolated from the target: kind of price for sin.

For the maximal dimension of this sub-space the negentropy gain is maximal. This deed would be good and by the proposed criterion the negentropic entanglement corresponds to love or more neutrally, positively colored conscious experience. Interestingly, there are $2^n - 1$ possible choices which is almost the dimension of Boolean algebra consisting of n independent bits. The excluded option corresponds to 0-dimensional sub-space - empty set in set theoretic realization of Boolean algebra. This could relate directly to fermionic oscillator operators defining basis of Boolean algebra- here Fock vacuum would be the excluded state. The deed in this sense would be a choice of how loving the attention towards system of external world is.

- (c) A map between between the different choices of k -dimensional sub-space to k -fermion states is suggestive. The realization of logic in terms of emotions of different degrees of positivity would be mapped to many-fermion states - perhaps zero energy states with vanishing total fermion number. State function reductions to k -dimensional spaces would be mapped to k -fermion states: quantum jumps to quantum states!

The problem brings in mind quantum classical correspondence in quantum measurement theory. The direction of the pointer of the measurement apparatus (in very metaphorical

sense) corresponds to the outcome of state function reduction, which is now 1-d sub-space. For ordinary measurement the pointer has n positions. Now it must have $2^n - 1$ positions. To the discrete space of n pointer positions one must assign fermionic Clifford algebra of second quantized fermionic oscillator operators. The hierarchy of Planck constants and dark matter suggests the realization. Replace the pointer with its space-time n -sheeted covering and consider zero energy states made of pairs of k -fermion states at the sheets of the n -sheeted covering? Dark matter would be therefore necessary for cognition. The role of fermions would be to “mark” the k space-time sheets in the covering.

2.4.5 ZEO and self

Zero energy ontology brings in additional aspects to the notion of self. Zero energy states correspond to entangled pairs of positive and negative energy states located at the opposite light-like boundaries of a given causal diamond (CD) defined as the intersection of future and past directed light-cones. Strictly speaking a Cartesian product of CD with CP_2 is in question. CDs form a fractal hierarchy. In the ordinary ontology zero energy state corresponds to a physical event. The time-like entanglement between positive and negative energy states defines M -matrix generalizing the notion of S -matrix. Time-like entanglement must be fundamental also from the point of view of consciousness as a reduction of quantum state to a state with well defined values of observables for the initial (positive energy) and final (negative energy) states.

The most important input from ZEO is that state function reductions can occur to both boundaries of CD. The natural identification of self is as a sequence of state functions occurring at fixed boundary of CD leaving the state at it invariant but affecting the opposite position of opposite boundary. This if one has superposition of CDs with zero energy states associated with them and of unitary process generates quantum superposition of CDs in the moduli space of CDs and if the unitary process is followed by a localization in this moduli space. The first quantum jump to opposite boundary corresponds to a state function reduction in ordinary sense and has interpretation as volitional act. Self dies and reincarnates at the opposite boundary of CD.

In this picture one can assign to self a definite age as the increase of the proper time distance between the tips of CD. Also the experience of time flow can be understood. In each death of self a reversal of geometric time occurs. This conforms with the old proposal of Fantappie that the notion of syntropy makes sense in living systems [J20],

2.4.6 Space-time correlates of self

The identification of the space-time correlates of selves is not so obvious as one might think. One can imagine three options. The space-time correlates of selves are space-time sheets or CDs or somehow combinations of these two.

1. If space-time sheets serve as correlates for selves, the space-time correlate for the entanglement is the presence of magnetic flux tubes connecting the space-time sheets serving as correlates for selves. The entanglement which corresponds to join along boundaries bonds associated with sub-selves (smaller space-time sheets topologically condensed at the space-time sheet representing self) is below the measurement resolution assignable to self. In this kind of situation selves remain conscious whereas sub-selves lose consciousness for positive entanglement entropy and fuse to form single stereo mental image of self. For negative entanglement entropy sub-selves would remain conscious.
2. In zero energy ontology [K6] one is forced to ask whether the correlates of self should be identified also at the level of embedding space rather than only at the level of space-time sheets so that a given CD would serve as a correlate for self. This identification leads to a beautiful argument for how the arrow of subjective time, the flow of subjective time, and the localization of the contents of conscious experience around a narrow time interval takes place [K2]. There is no reason for why CDs should not be allowed to overlap and this

overlap would be a natural correlate for the sharing and fusion of mental images. Both of these identifications look natural and one can argue that the geometric correlates of self exist at both embedding space and space-time level.

3. If both space-time sheets and CDs serve as correlates for selves, the magnetic flux tube contacts could connect space-time sheets associated with the two. CDs and would belong to their intersection. One can also require that the CDs are at the same p-adic level of hierarchy. In other words, CDs correspond to the same value of p-adic prime near a power of two meaning that the temporal distance between the tips of CDs is same octave of CP_2 time for the standard value of Planck constant. The hierarchy of Planck constants [K9] means an additional complication in this picture but does not bring in anything essentially new.

Since self behaves effectively like a separate autonomous universe, an attractive hypothesis is that the typical decomposition of self-organized system to almost autonomous subsystems corresponds to the decomposition of universe to selves. This means very close connection between self-organization theory and theory of consciousness.

2.4.7 Dark matter hierarchy and self

The notion of dark matter hierarchy has dramatically improve the understanding of the notion of self and together with NMP [K19] allows to even answer questions concerning Good and Evil and Life and Death [K31].

1. The idea about hierarchy of Planck constants emerged from anomalies of biology and the strange finding that planetary orbits could be regarded as Bohr orbits but with a gigantic value of Planck constant. This lead to the vision that dark matter corresponds to ordinary particles but with non-standard value of Planck constant and to a generalization of the 8-D embedding space to a book like structure with pages partially characterized by the value of Planck constant. Using the intuition provided by the inclusions of HFFs one ends up to a prediction for the spectrum of Planck constants. This inspires the proposal that dark matter could be in quantum Hall like phase localized at light-like 3-surfaces with macroscopic size and behaving in many respects like black hole horizons.
2. The physical interpretation for the hierarchy of Planck constants would be in terms of a hierarchy of quantum criticalities concretizing the vision about quantum criticality of TGD Universe. TGD Universe would be like a hill at the top of a hill at The larger the Planck constant the larger the size scale of the hill. Criticality involves crucially the notion of conformal gauge symmetry. The conformal symmetries correspond to some sub-algebra of the full algebra isomorphic to it acting as gauge symmetries and with conformal weights coming as n -multiples of those for the full symmetry algebra. $h_{eff} = n \times h$ would label the levels of the hierarchy. This hierarchy would correspond directly to the hierarchy of measurement resolutions and to hierarchy of HFFs. Also now one obtains infinite hierarchies of symmetry breakings and the identification with the hierarchies of inclusions of HFFs is compelling. Hence various hierarchies reflect the same underlying phenomenon.
3. The phase transitions reducing criticality would take place spontaneously unlike opposite phase transitions. This vision is especially powerful in biology, where homeostasis could be seen as mechanisms preventing the reduction of criticality but at expense of metabolic energy. The basic goal of living system would be staying at criticality. Eastern philosophies would formulate this fight for staying at criticality using the notions of ego and Karmic cycle. In the phase transition increasing $h_{eff} = n \times h$ part of gauge degrees of freedom assignable to a sub-algebra of the full super-symplectic algebra are transformed to physical ones and this implies better measurement resolution. The new HFF contains the previous one as a sub-factor. Evolution understood as increase of h_{eff} forced by Negentropy Maximization Principle as also interpretation improvement of measurement/cognitive resolution.

Dark matter hierarchy turns out to be crucial for the deeper understanding of the notion of self. In particular, the evolution of mental images as sequences of births and deaths of sub-selves correspond to state function reductions at opposite boundary of CD. These reductions are forced

by NMP and can be said to occur spontaneously. The value of h_{eff} increases in these state function reductions while it remains constant during the sequence of state function reductions at fixed boundary defining self. Quantum criticality is reduced in these phase transitions and self has to fight to stay at fixed level of criticality. Self achieves this by the use of metabolic energy and homeostasis. As long self stays at criticality - that is alive- it's sub-selves can evolve by deaths and re-incarnations.

Dark matter hierarchy suggests also a slight modification of the notion of self. Each self involves a hierarchy of dark matter levels, and one is led to ask whether the highest level in this hierarchy corresponds to single quantum jump rather than a sequence of quantum jumps. The averaging of conscious experience over quantum jumps would occur only for sub-selves at lower levels of dark matter hierarchy and these mental images would be ordered, and single moment of consciousness would be experienced as a history of events. One can ask whether even entire life cycle could be regarded as a single quantum jump at the highest level so that consciousness would not be completely lost even during deep sleep. This would allow to understand why we seem to know directly that this biological body of mine existed yesterday.

The fact that we can remember phone numbers with 5 to 9 digits supports the view that self corresponds at the highest dark matter level to single moment of consciousness. Self would experience the average over the sequence of moments of consciousness associated with each sub-self but there would be no averaging over the separate mental images of this kind, be their parallel or serial. These mental images correspond to sub-selves having shorter wake-up periods than self and would be experienced as being time ordered. Hence the digits in the phone number are experienced as separate mental images and ordered with respect to experienced time.

2.5 Four Views About How The Arrow Of Psychological Time Could Emerge

The notion of quantum jump implies a new view about time. Experienced/subjective time corresponds to a sequence of sub-quantum jumps and cannot be identified with the geometric time defined as the fourth space-time coordinate. This is of course obvious for anyone: consider only the reversibility of geometric time contra irreversibility of experienced time, and the fact that both geometric past and future exist whereas only subjective past exists. The fact that the contents of conscious experience is about 4-D rather than 3-D space-time region, motivates the notions of 4-D brain, body, and even society. In particular, conscious existence continues after biological death since 4-D body and brain continue to exist.

Quantum classical correspondence predicts that the arrow of subjective time is somehow mapped to that for the geometric time. The detailed mechanism for how the arrow of psychological time emerges has however remained open. Also the notion of self has been problematic. I have explained the most feasible solution to both problems already in the introduction and describe in the following other approaches which all rely on the same basic idea: the future for a point inside future light-cone has more room than past so that particle diffusing inside the light-cone gradually drifts to future.

1. First trial

The earliest model assumes that the space-time sheet assignable to observer ("self") drifts along a larger space-time sheet towards geometric future quantum jump by quantum jump: this is like driving car in a landscape but in the direction of geometric time and seeing the changing landscape. There are several objections.

1. Why this drifting?
2. If one has a large number of space-time sheets (the number is actually infinite) as one has in the hierarchy the drifting velocity of the smallest space-time sheet with respect to the largest one can be arbitrarily large (infinite).
3. It is alarming that the evolution of the background space-time sheet by quantum jumps, which must be the quintessence of quantum classical correspondence, is not needed at all in the model.

2. *Second trial*

Second model relies on the idea that intentional action -understood as p-adic-to-real phase transition for space-time sheets and generating zero energy states and corresponding real space-time sheets - proceeds as a kind of wave front towards geometric future quantum jump by quantum jump. Also sensory input would be concentrated on this kind of wave front. The difficult problem is to understand why the contents of sensory input and intentional action are localized so strongly to this wave front and rather than coming from entire life cycle.

3. *Third trial*

The third explanation for the arrow of psychological time considered earlier looks rather elegant but the explanation based on superpositions of CDs and state function reductions occurring at either boundary of CD looks more attractive.

1. In standard picture the attention would gradually shift towards geometric future and space-time in 4-D sense would remain fixed. Now however the fact that quantum state is quantum superposition of space-time surfaces allows to assume that the attention of the conscious observer is directed to a fixed volume of 8-D embedding space. Quantum classical correspondence is achieved if the evolution in a reasonable approximation means shifting of the space-time sheets and corresponding field patterns backwards backwards in geometric time by some amount per quantum jump so that the perceiver finds the geometric future in 4-D sense to enter to the perceptive field. This makes sense since the shift with respect to M^4 time coordinate is an exact symmetry of extremals of Kähler action. It is also an excellent approximate symmetry for the preferred extremals of Kähler action and thus for maxima of Kähler function spoiled only by the presence of light-cone boundaries. This shift occurs for both the space-time sheet that perceiver identifies itself and perceived space-time sheet representing external world: both perceiver and percept change.
2. Both the landscape and observer space-time sheet remain in the same position in embedding space but both are modified by this shift in each quantum jump. The perceiver experiences this as a motion in 4-D landscape. Perceiver (Mohammed) would not drift to the geometric future (the mountain) but geometric future (the mountain) would effectively come to the perceiver (Mohammed)!
3. There is an obvious analogy with Turing machine: what is however new is that the tape effectively comes from the geometric future and Turing machine can modify the entire incoming tape by intentional action. This analogy might be more than accidental and could provide a model for quantum Turing machine operating in TGD Universe. This Turing machine would be able to change its own program as a whole by using the outcomes of the computation already performed.
4. The concentration of the sensory input and the effects of conscious motor action to a narrow interval of time (.1 seconds typically, secondary p-adic time scale associated with the largest Mersenne M_{127} defining p-adic length scale which is not completely super-astronomical) can be understood as a concentration of sensory/motor attention to an interval with this duration: the space-time sheet representing sensory “me” would have this temporal length and “me” definitely corresponds to a zero energy state.
5. The fractal view about topological quantum computation strongly suggests an ensemble of almost copies of sensory “me” scattered along my entire life cycle and each of them experiencing my life as a separate almost copy.
6. The model of geometric and subjective memories would not be modified in an essential manner: memories would result when “me” is connected with my almost copy in the geometric past by braid strands or massless extremals (MEs) or their combinations (ME parallel to magnetic flux tube is the analog of Alfvén wave in TGD).

This argument leaves many questions open. What is the precise definition for the volume of attention? Is the attention of self doomed to be directed to a fixed volume or can quantum jumps change the volume of attention? What distinguishes between geometric future and past as far

as contents of conscious experience are considered? How this picture relates to p-adic and dark matter hierarchies? Does this framework allow to formulate more precisely the notion of self?

4. The recent view

As mentioned in the beginning, ZEO forces a generalization of quantum measurement theory explaining how the flow and arrow of time emerge. ZEO also reduces the notion of self to observer identified as the sequence of state function reductions to a fixed boundary of CD, whose size (or possibly average quantum size) increases during the sequence of reductions. There is also strong temptation to identify the sequence of reductions at fixed boundary of CD as sequence of unitary evolutions inducing shift of the integer n characterizing the size of CD.

The first state function to the opposite boundary of CD would correspond to a scaling of CD size by the integer $m = n_f/n_i$ defined by the integers h_{eff}/h for scaled up CD and the original one. A sequence of transitions reducing quantum criticality would be in question and all big ideas of quantum TGD would find each other in the picture. Minimization of assumptions and maximization of predictive power selects this model as the most plausible one.

2.6 What Really Distinguishes Between Future And Past?

Our knowledge about geometric future is very uncertain as compared to that about geometric past. Hence we usually use words like plan/hunch/hope/... in the case of geometric future and speak about memories in the case of geometric past. We also regard geometric past as something absolutely stable. Why cannot we “remember” geometric future as reliably as the geometric past? Is it that geometric future is highly unstable as compared to the geometric past? Why this should be the case? Or could it be that it does not really exist?

ZEO provides again the most convincing explanation for the asymmetry between future and past. The low unchanging boundary of CD corresponds to the most remote geometric past and is completely stable during the sequence of state function reductions defining self. The active, changing boundary of CD (or superposition of them), which corresponds to “sensory now” is replaced with a new one in every reduction. The geometric past corresponds to the regions of CD “below” it. This asymmetry between future and past explains why remembering future is difficult if not even impossible for given self.

The fact is however that we can make predictions about our future. One can indeed consider a loop-hole making possible to predict future to some extent. As self dies and new self wakes up at opposite boundary of corresponding CD the arrow of time changes and past becomes future. This self has memories about what corresponds to the future of the original self. If this information is preserved when the original self wakes up and is accessible to it, this self can pre-cognize its future to some degree. An attractive idea is that during sleep the sub-self representing “wake-up me” dies and is replaced with a new one. During sleep the new self would recall information about its geometric past and this information would be partially accessible to the original sub-self after wake-up.

2.7 Two Views About Flow Of Time

One can consider two alternative views about how the subjectively experienced flow of time emerges.

1. The first view would identify the flow of time with life cycle of period and essentially with sensory perception defining the passive aspects of consciousness. This view is consistent with the ZEO based about self and looks rather feasible. One can wonder how repeated state function reduction give rise to the increase of the average size of CD (possibly in superposition of CDs). Why the entire zero energy state and CD do not remain unchanged in state function reduction? What is the unitary process defining the dynamics of dispersion in the moduli space of CDs? One must admit that this aspect is not well-understood yet and more detailed view about what the sequences of state function reductions really means.
2. Second view that I have considered assigns the flow of time with active aspects of consciousness.

- (a) The acts of volition would give rise to an experience about flow of time. The proposal is that in ZEO act of volition corresponds to the first state function reduction at the opposite boundary of some sub-CD. Some self in the hierarchy dies in this process and NMP forces it to occur although it does not fix the outcome.

Time mirror mechanism for motor action assumes that the phase transition gives rise to negative energy space-time sheets representing propagation of signals to geometric past, where they induce neuronal activities. From Libet's experiments relating to neuronal correlates of volition the time scale involved is a fraction of second but an infinite hierarchy of time scales is implied by fractality. Perhaps the most logical interpretation is that state function reduction sequences with opposite arrows of time correspond to sensory perception and motor action from the point of view of a higher level self with larger CD.

- (b) Skeptic can argue that the act of volition in this sense is only a choice between alternative outcomes of state function reduction rather than a realization of intention as action creating something genuinely new: a new real space-time sheet from p-adic space-time sheet. One can however argue that genuine volitional acts are realizations of intentions. The reason is that NMP defines the goal of the dynamics and means that total quantum randomness does not prevail anymore.

One can also argue that there is no actual choices between good and evil. This is certainly not the case if weak form of NMP which only allows the reduction to any subspace of the subspace with the dimension of the projection operator appearing in density matrix.

These view can be understood as mutually consistent ways to understand the flow of time. The first flow would be pseudo-continuous and correspond to translation in time and second one would occur in discontinuous steps and correspond a scaling of CD. These time developments corresponds to time evolutions in ordinary QFT and in conformal field theory respectively.

Consider first how the smooth flow of subjective time during the life cycle of self emerges.

1. One can argue that the value of h_{eff} associated with a given self cannot increase during the lifetime of self since this would scale up also the size of the passive boundary of CD and thus also the sizes of 3-surfaces there. The explanation for the flow of geometric time however demands that the size of CDs in the superposition increases.

This requires a linear increase in which CD size increases by integer rather than being scaled by integer: shift instead of scaling. This criterion would suggests that the increase of the size of CD is below scaling by factor two - below a more flexible option is considered - and relate the lifetime of self to the size scale of CD.

2. The basic mathematical challenge is to formulate the transition amplitudes between different CDs. Is the transition amplitude essentially an overlap of fermionic lines associated with the two CDs? In Yangian approach the transition amplitude would reduce to an overlap integral associated with the string world sheets belonging to both CDs. This would favor the increase of the size of CD. It is not clear whether it makes sense to assume a localization to single CD to take place at every step localizing only its active boundary. Certainly state function reduction in the degrees of freedom associated with this boundary of CD cannot occur since this would reverse the direction of time.

The time evolution during the single step keeping passive boundary of CD corresponds to a shift for the integer specifying the size scale of CD. Can one interpret this shift as a fractional scaling $n \rightarrow n(1 + \Delta n/n)$ or does this shift correspond to translation by representable in terms of Poincare energy as Noether charge? The latter option looks more natural. This time evolution would be the one usually studied in quantum field theories.

3. Interesting questions relate to the constraints coming from number theoretical universality forced by adelization. Could the increase of h_{eff} correspond to the increase of p-adic prime characterizing the system? What about p-adic counterpart of unitary evolution: the existence of the exponential $exp(iP_0t)$ requires that t has p-adic norm below some upper bound. This

could give an upper bound to the life time of self as a real number since the p-adic counterpart of life-time would be below this upper bound.

What happens in the first reduction to the opposite boundary of CD changing the arrow of time?

1. The reduction should be forced by NMP and involve scaling of h_{eff} generating negentropic entanglement. Thus the scaling of h_{eff} and reduction of quantum criticality would be possible only in the first reduction to the opposite boundary - biological death. Life cycle would end when the transition increasing h_{eff} would occur and at least tend increase negentropic entanglement. The tendency of living system to stay at criticality using metabolism and homeostasis would translate to the urge to maximize the life span, which looks indeed natural.
2. At the level of sub-selves this scalings can occur for self and would correspond to mental images with are born and die. Also motor action would correspond to a transition changing the arrow of time for a mental image representing the intention and will to perform the motor action.
3. One can argue that the increase of h_{eff} giving also rise to an increase in negentropy becomes unavoidable eventually. This criticality could mean that the size scale of CD becomes integer multiple of the original one.

For instance, when the size scale of personal CD approaches to a value which is twice that of the original one, the situation is expected become highly critical for $h_{eff} \rightarrow 2 \times h_{eff}$ transition. Could it be possible to avoid this phase transition so that the biological death could correspond to $h_{eff} \rightarrow n \times h_{eff}$, $n > 2$? The manner to avoid the phase transition would be by the generation of negentropic entanglement at the level of mental images and by the corresponding phase transitions for them - can one see spiritual thoughts as a way to live longer?

4. In the first reduction to the opposite boundary the negentropy increases and also the value of h_{eff} presumably does (by NMP). Does this mean that self can gain wisdom only by dying! The intuitive idea is that ageing is accompanied by increase of wisdom of some kind. But *if* one assigns negentropic entanglement with the passive boundary, negentropy associated with the length scale of CD remains unchanged.

There is however a loophole. For the sub-selves associated with sub-CDs the situation is different. Given mental image of self/sub-self can live several life-cycles meaning that it generates (or can generate) negentropic entanglement. Mental images of self get wiser even if self does not! The refusal of self to grow spiritually would make possible for sub-selves to grow spiritually: one cannot cheat NMP!

5. The scaling of CD inducing the increase of $h_{eff} = n \times h$ occurring spontaneously represented as an exponential of scaling generator - call it L_0 - seems to be precede the first reduction. I have already considered conditions on this dynamics. Note that translations are replaced with scalings by integer valued ratios $m = n_f/n_i$, which predicts that periodicity is replaced by periodicity with respect to the logarithm of ordinary embedding space time. A unique signature of dynamics of consciousness, which I have proposed as an explanation for the hyperbolic decay law for the emission of bio-photons.
6. The scaling of CD inducing the increase of $h_{eff} = n \times h$ occurring spontaneously is naturally represented as an exponential of scaling generator - call it L_0 . Translations are replaced with scalings by integer valued ratios $m = n_f/n_i$, which predicts that periodicity is replaced by periodicity with respect to the logarithm of ordinary embedding space time. A unique signature of dynamics of consciousness, which I have proposed as an explanation for the hyperbolic decay law for the emission of bio-photons.
7. The phase transitions increasing $h_{eff}/h = n$ can be said to begin from some prime value $n = p$ - the smallest prime power appearing in n : one could even say that the basic label for the sequences of breakings of super-symplectic symmetries are labelled by primes. This strongly suggests a connection with p-adicity.

These two views are consistent with each other. The first view corresponds to a flow of time as shifts in the integer characterizing the size of CD and corresponds to the flow of time experienced by self during its life-cycle. The second view corresponds to time evolution as a sequence of state function reductions at opposite boundary involving scalings of h_{eff} by integer. The tick for this clock would be a phase transition reducing quantum criticality. Self experiences this time flow as sequence of mental images which live and die.

3 Intention, Cognition, And Time

Intentions involved time in an essential manner and this led to the idea that p-adic-to-real quantum jumps could correspond to a realization of intentions as actions. It however seems that this hypothesis posing strong additional mathematical challenges is not needed if one accepts adelic approach in which real space-time time and its p-adic variants are all present and quantum physics is adelic. I have already earlier developed the first formulation of p-adic space-time surface in [K35] and the ideas related to the adelic vision in [K24, K22, K1].

The recent view involving strong form of holography would provide dramatically simplified view about how these representations are formed as continuations of representations of strings world sheets and partonic 2-surfaces in the intersection of real and p-adic variants of WCW (“World of Classical Worlds”) in the sense that the parameters characterizing these representations are in the algebraic numbers in the algebraic extension of p-adic numbers involved.

3.1 What Intentions Are?

One of the earlier ideas about the flow of subjective time was that it corresponds to a phase transition front representing a transformation of intentions to actions and propagating towards the geometric future quantum jump by quantum jump. The assumption about this front is unnecessary in the recent view inspired by ZEO.

Intentions should relate to active aspects of conscious experience. The question is what the quantum physical correlates of intentions are and what happens in the transformation of intention to action.

1. The old proposal that p-adic-to-real transition could correspond to the realization of intention as action. One can even consider the possibility that the sequence of state function reductions decomposes to pairs real-to-p-adic and p-adic-to-real transitions. This picture does not explain why and how intention gradually evolves stronger and stronger, and is finally realized. The identification of p-adic space-time sheets as correlates of cognition is however natural.
2. The newer proposal, which might be called adelic, is that real and p-adic space-time sheets form a larger sensory-cognitive structure: cognitive and sensory aspects would be simultaneously present. Real and p-adic space-time surfaces would form single coherent whole which could be called adelic space-time. All p-adic manifolds could be present and define kind of chart maps about real preferred extremals so that they would not be independent entities as for the first option. The first objection is that the assignment of fermions separately to the every factor of adelic space-time does not make sense. This objection is circumvented if fermions belong to the intersection of realities and p-adicities.

This makes sense if string world sheets carrying the induced spinor fields define seats of cognitive representations in the intersection of reality and p-adicities. Cognition would be still associated with the p-adic space-time sheets and sensory experience with real ones. What can sensed and cognized would reside in the intersection.

Intention would be however something different for the adelic option. The intention to perform quantum jump at the opposite boundary would develop during the sequence of state function reductions at fixed boundary and eventually NMP would force the transformation of intention to action as first state function reduction at opposite boundary. NMP would guarantee that the urge to do something develops so strong that eventually something is done.

Intention involves two aspects. The plan for achieving something which corresponds to cognition and the will to achieve something which corresponds to emotional state. These aspects could correspond to p-adic and real aspects of intentionality.

3.2 P-Adic Physics As Physics Of Only Cognition?

There are two views about p-adic-real correspondence corresponding to two views about p-adic physics. According to the first view p-adic physics defines correlates for both cognition whereas second view states that it provides correlates for cognition only.

1. Option A: The older view is that p-adic \rightarrow real transitions realize intentions as actions and opposite transitions generate cognitive representations. Quantum state would be either real or p-adic. This option raises hard mathematical challenges since scattering amplitudes between different number fields are needed and the needed mathematics might not exist at all.
2. Option B: Second view is that cognition and sensory aspects of experience are simultaneously present at all levels and means that real space-time surface and their real counterparts form a larger structure in the spirit of what might be called Adelic TGD. p-Adic space-time charts could be present for all primes. It is of course necessary to understand why it is possible to assign definite prime to a given elementary particle.

This option could be developed by generalizing the existing mathematics of adèles by replacing number in given number field with a space-time surface in the embedding space corresponding that number field. Therefore this option looks more promising. For this option also the development of intention can be also understood. The condition that the scattering amplitudes are in the intersection of reality and p-adicities is very powerful condition on the scattering amplitudes and would reduce the realization of number theoretical universality and p-adicization to that for string world sheets and partonic 2-surfaces.

For instance, the difficult problem of defining p-adic analogs of topological invariant would trivialize since these invariants (say genus) have algebraic representation for 2-D geometries. 2-dimensionality of cognitive representation would be perhaps basically due to the close correspondence between algebra and topology in dimension $D = 2$.

Most of the following considerations apply in both cases.

3.3 Some Questions To Ponder

The following questions are part of the list of question that one must ponder.

3.3.1 Do cognitive representations reside in the intersection of reality and p-adicities?

The idea that cognitive representation reside in the intersection of reality and various p-adicities is one of the key ideas of TGD inspired theory of consciousness.

1. All quantum states have vanishing total quantum numbers in ZEO, which now forms the basis of quantum TGD [K5]. In principle conservation laws do not pose any constraints on possibly occurring real-p-adic transitions (Option A) if they occur between zero energy states.

On the other hand, there are good hopes about the definition of p-adic variants of conserved quantities by algebraic continuation since the stringy quantal Noether charges make sense in all number fields if string world sheets are in the real-p-adic intersection. This continuation is indeed needed if quantum states have adelic structure (Option B). In accordance with this quantum classical correspondence (QCC) demands that the classical conserved quantities in the Cartan algebra of symmetries are equal to the eigenvalues of the quantal charges.

2. The starting point is the interpretation of fermions as correlates for Boolean cognition and p-adic space-time sheets space-time correlates for cognitions [K29]. Induced spinor fields are localized at string world sheets, which suggests that string world sheets and partonic

2-surfaces define cognitive representations in the intersection of realities and p-adicities. The space-time adele would have a book-like structure with the back of the book defined by string world sheets.

3. At the level of partonic 2-surfaces common rational points (or more generally common points in algebraic extension of rationals) correspond to the real–p-adic intersection. It is natural to identify the set of these points as the intersection of string world sheets and partonic 2-surfaces at the boundaries of CDs. These points would also correspond to the ends of strings connecting partonic 2-surfaces and the ends of fermion lines at the orbits of partonic 2-surfaces (at these surfaces the signature of the induced 4-metric changes). This would give a direct connection with fermions and Boolean cognition.
 - (a) For option A the interpretation is simple. The larger the number of points is, the higher the probability for the transitions to occur. This because the transition amplitude must involve the sum of amplitudes determined by data from the common points.
 - (b) For option B the number of common points measures the goodness of the particular cognitive representation but does not tell anything about the probability of any quantum transition. It however allows to discriminate between different p-adic primes using the precision of the cognitive representation as a criterion. For instance, the non-determinism of Kähler action could resemble p-adic non-determinism for some algebraic extension of p-adic number field for some value of p . Also the entanglement assignable to density matrix which is n -dimensional projector would be negentropic only if the p-adic prime defining the number theoretic entropy is divisor of n . Therefore also entangled quantum state would give a strong suggestion about the value of the optimal p-adic cognitive representation as that associated with the largest power of p appearing in n .

3.3.2 Could cognitive resolution fix the measurement resolution?

For p-adic numbers the algebraic extension used (roots of unity fix the resolution in angle degrees of freedom and binary cutoffs fix the resolution in “radial” variables which are naturally positive. Could the character of quantum state or perhaps quantum transition fix measurement resolution uniquely?

1. If transitions (state function reductions) can occur only between different number fields (Option A), discretization is un-avoidable and unique if maximal. For real-real transitions the discretization would be motivated only by finite measurement resolution and need be neither necessary nor unique. Discretization is required and unique also if one requires adelic structure for the state space (Option B). Therefore both options A and B are allowed by this criterion.
2. For both options cognition and intention (if p-adic) would be one half of existence and sensory perception and motor actions would be second half of existence at fundamental level. The first half would correspond to sensory experience and motor action as time reversals of each other. This would be true even at the level of elementary particles, which would explain the amazing success of p-adic mass calculations.
3. For option A the state function reduction sequence would correspond to a formation of p-adic maps about real maps and real maps about p-adic maps: $\text{real} \rightarrow \text{p-adic} \rightarrow \text{real} \rightarrow \dots$. For option B it would correspond the sequence adelic \rightarrow adelic \rightarrow adelic $\rightarrow \dots$.
4. For both options p-adic and real physics would be unified to single coherent whole at the fundamental level but the adelic option would be much simpler. This kind of unification is highly suggestive - consider only the success of p-adic mass calculations - but I have not really seriously considered what it could mean.

3.3.3 What selects the preferred p-adic prime?

What determines the p-adic prime or preferred p-adic prime assignable to the system considered? Is it unique? Can it change?

1. An attractive hypothesis is that the most favorable p-adic prime is a factor of the integer n defining the dimension of the $n \times n$ density matrix associated with the flux tubes/fermionic strings connecting partonic 2-surfaces: the presence of fermionic strings already implies at least two partonic 2-surfaces. During the sequence of reductions at same boundary of CD n receives additional factors so that p cannot change. If wormhole contacts behave as magnetic monopoles there must be at least two of them connected by monopole flux tubes. This would give a connection with negentropic entanglement and for $h_{eff}/h = n$ to quantum criticality, dark matter and hierarchy of inclusions of HFFs.
2. Second possibility is that the classical non-determinism making itself visible via super-symplectic invariance acting as broken conformal gauge invariance has same character as p-adic non-determinism for some value of p-adic prime. This would mean that p-adic space-time surfaces would be especially good representations of real space-time sheets. At the lowest level of hierarchy this would mean large number of common points. At higher levels large number of common parameter values in the algebraic extension of rationals in question.

3.3.4 How finite measurement resolution relates to hyper-finite factors?

The connection with hyper-finite factors suggests itself.

1. Negentropic entanglement can be said to be stabilized by finite cognitive resolution if hyper-finite factors are associated with the hierarchy of Planck constants and cognitive resolutions. For HFFs the projection to single ray of state space in state function reduction is replaced with a projection to an infinite-dimensional sub-space whose von Neumann dimension is not larger than one.
2. This raises interesting question. Could infinite integers constructible from infinite primes correspond to these infinite dimensions so that prime p would appear as a factor of this kind of infinite integer? One can say that for inclusions of hyperfinite factors the ratio of dimensions for including and included factors is quantum dimension which is algebraic number expressible in terms of quantum phase $q = \exp(i2\pi/n)$. Could n correspond to the integer ratio $n = n_f/n_i$ for the integers characterizing the sub-algebra of super-symplectic algebra acting as gauge transformations?

3.4 Generalizing The Notion Of P-Adic Space-Time Surface

The notion of p-adic manifold [K35] is an attempt to formulate p-adic space-time surfaces identified as preferred extremal of p-adic variants of p-adic field equations as cognitive charts of real space-time sheets. Here the essential point is that p-adic variants of field equations make sense: this is due to the fact that induced metric and induced gauge fields make sense (differential geometry exists p-adically unlike global geometry involving notions of lengths, area, etc does not exist: in particular the notion of angle and conformal invariance make sense).

The second key element is finite resolution so that p-adic chart map is not unique. Same applies to the real counterpart of p-adic extremal and having representation as space-time correlate for an intention realized as action.

The discretization of the entire space-time surface proposed in the formulation of p-adic manifold concept [K35] looks too naïve an approach. It is plausible that one has an abstraction hierarchy for discretizations at various abstraction levels.

1. The simplest discretization would occur at space-time level only at partonic 2-surfaces in terms of string ends identified as algebraic points in the extension of p-adics used. For the boundaries of string world sheets at the orbits of partonic 2-surface one would have discretization for the parameters defining the boundary curve. By field equations this curve is actually a segment of light-like geodesic line and characterized by initial light-like 8-velocity, which should be therefore a number in algebraic extension of rationals. The string world sheets should have similar parameterization in terms of algebraic numbers.

By conformal invariance the finite-dimensional conformal moduli spaces and topological invariants would characterize string world sheets and partonic 2-surfaces. The p-adic variant of

Teichmueller parameters was indeed introduced in p-adic mass calculations and corresponds to the dominating contribution to the particle mass [K17, K4].

2. What might be called co-dimension 2 rule for discretization suggests itself. Partonic 2-surface would be replaced with the ends of fermion lines at it or equivalently: with the ends of space-like strings connecting partonic 2-surfaces at it. 3-D partonic orbit would be replaced with the fermion lines at it. 4-D space-time surface would be replaced with 2-D string world sheets. Number theoretically this would mean that one has always commutative tangent space. Physically the condition that em charge is well-defined for the spinor modes would demand co-dimension 2 rule.
3. This rule would reduce the real-p-adic correspondence at space-time level to construction of real and p-adic space-time surfaces as pairs to that for string world sheets and partonic 2-surfaces determining algebraically the corresponding space-time surfaces as preferred extremals of Kähler action. Strong form of holography indeed leads to the vision that these geometric objects can be extended to 4-D space-time surface representing preferred extremals.
4. In accordance with the generalization of AdS/CFT correspondence to TGD framework cognitive representations for physics would involve only partonic 2-surfaces and string world sheets. This would tell more about cognition rather than Universe. The 2-D objects in question would be in the intersection of reality and p-adicities and define cognitive representations of 4-D physics. Both classical and quantum physics would be adelic.
5. Space-time surfaces would not be unique but possess a degeneracy corresponding to a sub-algebra of the super-symplectic algebra isomorphic to it and acting as conformal gauge symmetries giving rise to n conformal gauge invariance classes. The conformal weights for the sub-algebra would be n -multiples of those for the entire algebra and n would correspond to the effective Planck constant $\hbar_{eff}/\hbar = n$. The hierarchy of quantum criticalities labelled by n would correspond to a hierarchy of cognitive resolutions defining measurement resolutions.

Clearly, very many big ideas behind TGD and TGD inspired theory of consciousness would have this picture as a Boolean intersection.

3.5 Number Theoretic Universality For Cognitive Representations

Number theoretic universality is one of the key principles of quantum TGD [K21]. In the following this principle is discussed in the light of the newest results about quantum TGD.

1. By number theoretic universality p-adic zero energy states should be formally similar to their real counterparts for option B. For option A the states between which real-p-adic transitions are highly probable would be similar. The states would have as basic building bricks the elements of the Yangian of the super-symplectic algebra associated with these strings which one can hope to be algebraically universal.
2. Finite measurement resolution demands that all scattering amplitudes representing zero energy states involve discretization. In purely p-adic context this is unavoidable because the notion of integral is highly problematic. Residue integral is p-adically well-defined if one can deal with π .

p-Adic integral can be defined as the algebraic continuation of real integral made possible by the notion of p-adic manifold and this works at least in the real-p-adic intersection. String world sheets would belong to the intersection if they are cognitive representations as the interpretation of fermions as correlates of Boolean cognition suggests. In this case there are excellent hopes that all real integrals can be continued to various p-adic sectors (which can involve algebraic extensions of p-adic number fields). Quantum TGD would be adelic. There are of course potential problems with transcendentals like powers of π .

3. Discrete Fourier analysis allows to define integration in angle degrees of freedom represented in terms of algebraic extension involving roots of unity. In purely p-adic context the notion of angle does not make sense but trigonometric functions make sense: the reason is that

only the local aspect of geometry generalize characterized by metric generalize. The global aspects such as line length involving integral do not. One can however introduce algebraic extensions of p-adic numbers containing roots of unity and this gives rise to a realistic notion of trigonometric function. One can also define the counterpart of integration as discrete Fourier analysis in discretized angle degrees of freedom.

4. Maybe the 2-dimensionality of cognition has something to do with the fact that quaternions and octonions do not have p-adic counterpart (the p-adic norm squared of quaternion/octonion can vanish). I have earlier proposed that life and cognitive representations resides in real-p-adic intersection. Stringy description of TGD could be seen as number theoretically universal cognitive representation of 4-D physics. The best that the limitations of cognition allow to obtain. This hypothesis would also guarantee that various conserved quantal charges make sense both in real and p-adic sense as p-adic mass calculations demand.

3.6 Why P-Adic Intentionality Does Not Reduce To Quantum Randomness?

The basic argument against quantal free will is that quantum non-determinism is basically randomness of a particular kind so that one can apply statistical determinism to predict the behavior for an ensemble of systems. The crucial question is whether also intentionality in the proposed sense reduces to randomness so that statistical determinism applies. One can imagine several mutually consistent approaches to the problem.

1. The notion of randomness is based on the notion of probability, and it could happen that the notion of probability simply does not make sense at all for a system exhibiting an intentional behavior or that the probabilities do not exist in the real sense but only as p-adic probabilities. Thus abnormal statistics might serve as a signature of an intentional system.
2. Intentionality involves free will and unpredictability in short time scales but predictability in long time scales. This could serve as a signature of an intentional system. Quantum-classical correspondence states that the dynamics of space-time surface mimics quantum dynamics and therefore also the dynamics of consciousness and intentionality. If so the behavioral patterns of an intentional system characterized by p-adic prime p should obey p-adic topology, which is a strong and testable prediction.
3. Zero Energy Ontology and the notion of negentropic entanglement provide a further perspective to the problem. Intentionality means goal directed behavior. NMP implies that the increase of negentropy is the universal goal. Universe builds negentropic entanglement servings as kind of Akashic records. One could therefore say that it is NMP that intends and wants. The outcome of the state function reduction at the opposite boundary of CD is forced by NMP and the plan for making it and the will to do do it should characterize the contents of consciousness associated with the self defined by a sequences of state function reductions at given boundary of CD. NMP also implies that the outcome of state function reduction is not random since entanglement negentropy is preserved or even increases. Of course, negentropic entanglement can be transferred between different systems.

3.6.1 p-Adic topology for time series as a signature of intentionality

Intentional behavior means that there is unpredictability in short time scales but predictability in long time scales because system can realize its long term plans and use its partially free will to cope with the changing challenges of the everyday life.

p-Adic topology could realize this idea.

1. The rational values of real and p-adic embedding space coordinates correspond to the same points of the generalized embedding space (essentially union of real and p-adic embedding spaces for various values of p with common rational points identified).
2. The points, which are p-adically close to each other can have arbitrarily long real distance since the points x and $x + kp^n$, $k \in \{0, p-1\}$, become arbitrarily near to each other p-adically

and arbitrarily far way in real sense as n increases for the p-adic topology characterized by prime p .

Thus p-adic long range fractal correlations could simply result from p-adic continuity. The local unpredictability would be mimicked by a discontinuous behavior in the real topology resulting from the fact that time values close to each other in the real sense are far from each other in p-adic sense.

p-Adic non-determinism means that integration constants of p-adic differential equations having by definition vanishing derivatives, are functions of the binary cutoffs x_N defined as $x = \sum_k x_k p^k \rightarrow x_N = \sum_{k < N} x_k p^k$ of the arguments of the function. Since the rational values of real and p-adic coordinates correspond to same points of embedding space, this means that p-adic non-determinism realizes intentionality by fixing the solution of field equations at a finite number of points below some real time (length) scale defined by N . The choice of these pseudo constants would characterize p-adic intentionality, the future plan of the system relatively stable against quantum jumps and the range of intentional action would be finite, which could explain why the young person in the geometry youth now cannot make choices affecting dramatically the geometric now decades later.

There is an analogous non-determinism also in the real sector due to the dramatic failure of the complete non-determinism of the basic action principle determining the dynamics of space-time surfaces. This non-determinism justifies the characterization of the real space-time sheets by a p-adic primes.

Consider now a situation in which some observables of might -be intentional system are measured as a function of time. Suppose that measurements are carried out at moments $t_n = n\Delta T$, $\Delta T = T/N_m$, where T is the duration of the experiment and N_m is the number of measurements.

1. With respect to the real topology the behavior of the system would look random in short time scales with violent discontinuities independently how precise the time resolution is made: fluctuations would actually become more violent with the improving time resolution.
2. p-Adic fractality would predict long range correlations over arbitrarily long time scales p^n in this kind of situation. Time values t and $t + rp^k \Delta T$ would be near to each other p-adically so that the values of the observables measured at these time values would be near to each other. Long range temporal correlations would thus quantify the ideas that will is not completely free and that intentionality implies an approximate predictability in long time scales. The fact that p-adic pseudo constants allow intentional free will only below some time and length scales, justifies the idea that our life is in long time scales determined by what might be called fate although we can make freely decisions in short time scales. The stability of the p-adic pseudo constants and binary cutoff N in quantum jumps would also mean that the realization of p-adic intentions occurring subjectively now in my geometric childhood would not have dramatic implications in the geometric now.
3. p-Adic fractality would also mean that similar behavioral time patterns could repeat themselves as temporally scaled-up versions. Person would react in a similar manner in different time scales, say in stressing situation lasting for few minutes or many years. What is used to call as personality might have something to do with these fractal behavioral patterns. There is indeed statistical evidence for the possibility to predict much about the life cycle of a person from the behavioral patterns in childhood. The child who wants all now tends to become an adult who does the same. Some aspects of personality would perhaps represent something not invariant under time translations but under p-adic time scalings.

3.6.2 How statistical behavior could exhibit intentionality?

Consider an ensemble of consisting of N_m measurements of some observables of a system during a fixed time interval T occurring at equally spaced moments of time $t_n = n \times \Delta T$, $\Delta T = T/N_m$. Classify the measurements by some equivalence relation so that there are I possible outcomes and estimate the probabilities for the outcomes as rational numbers $p_i = n_i/N_m$, $\sum n_i = N_m$. When N_m becomes large one should obtain estimates for the probabilities of various instances labelled by $i = 1, \dots, I$. The standard frequency interpretation of probability theory relies on the assumption is that these estimates converge in real topology so that the estimates $p(i, N_m + k) = n_i/N_m + k$, $k \ll N_m$ and $p(i, N_m) = n_i/N_m$ do not differ much for large values of N_m .

It is however quite possible that $p(N_m)$ converges in some p-adic topology which would mean that in the real topology the estimates would fluctuate wildly without any convergence, in a typically fractal manner. The estimates for probabilities would however converge p-adically in which case the system would be intentional and characterized by some p-adic prime p . The quantum-classical correspondence suggests that the sequence of N_m measurements performed for an intentional system during time interval T can be modelled as a sequence of measurements performed for a p-adic space-time sheet serving as its correlate. With this assumption one can immediately conclude that the estimates for the probabilities do not converge since various observables are continuous functions with respect to p-adic rather than real topology and ΔT does not approach zero at the limit $N_m \rightarrow \infty$ but fluctuates wildly. Only for N_m and $N_m + kp^n$ p-adic continuity guarantees that probabilities estimated in this manner are near each other.

It must be emphasized that the notion of p-adic probability based on frequency interpretation satisfies the Kolmogorov axioms as demonstrated by [A1] [A1]. The notion of resolution $\Delta T = T/N_m$ defining what $N_m \rightarrow \infty$ limit really means is an absolutely essential additional element. If one defines $N_m \rightarrow N_m + 1$ as an addition of one additional measurement to existing sequence of measurements, the frequencies convergence to ordinary real probabilities with a given resolution since only one of the numbers n_i changes in $N_m \rightarrow N_m + 1$. The notion of resolution makes sense also in spatial degrees of freedom.

The notion of resolution is unavoidable already in quantum field theories in order to reduce degrees of freedom which are not directly experimentally detectable since the that measurement resolution is always finite. The notion of renormalization group realizes mathematically the notion of finite resolution [?]. Thus resolution dependent statistics is not anything new. What is new is p-adicity and the long range correlations reducing to the p-adic continuity because of different concept of nearness. Note also that p-adically small structures have real sizes which are astrophysical so that cognition is naturally an astrophysical phenomenon in accordance with the notions of magnetic body and ME.

These considerations suggests how one could try to demonstrate p-adic intentionality experimentally.

1. One might hope of demonstrating that intentional systems behave apparently randomly in short time scales but that there are long range temporal correlations in time scales $t_n = p^n \Delta T$, $\Delta T = T/N_m$. Wild fluctuation of the probability estimates as function of N_m is a direct signature of intentionality. The approximate invariance of the frequencies under the transformations $N_m \rightarrow N_m + p^n \Delta T$ in turn allow to identify the value p . This approach could be used to prove the presence of the p-adic intentionality even at the molecular level or at level of say solar and planetary magnetospheres by studying the temporal behavior of the fluctuations of magnetic fields. For instance, it is known that solar magnetic field has what might be called memory [?], which should not be there if it were really random. For tornadoes the presence of short range chaos and long range order in at least spatial degrees of freedom is obvious. Period doubling in the systems approaching chaos could be a signature for the appearance of 2-adic intentionality in increasingly longer time scales. Also $1/f$ noise, not really understood in standard physics framework, might be related to intentionality.
2. One could also test the number theoretic information measures suggested by the p-adic approach using preferred resolutions defined by $N_m = kp^n$. Number theoretic information measures make sense for rational valued probabilities, and are obtained from Shannon entropy by replacing ordinary logarithm with the p-adic logarithm $Log_p(x) = \log(|x|_p) = \log(p^k) = k \log(p)$ to get $S_p = -\sum_n p_n Log_p(p_n)$. The number theoretic entropies can have also negative values in which case one can say that the ensemble contains genuine information.

3.6.3 How the p-adic primes involved with intentionality and ordinary physics are related?

In real physics the p-adic primes involved are very large, for instance, $p = 2^{127} - 1$ for electron. These large primes however labels real space-time sheets and characterize their fractality and *effective* p-adic topology. p-Adic length scale hypothesis in its basic form predicts that primary and n-ary length/time scales correspond to powers of $\sqrt{2}$ of the fundamental p-adic length/time scales so that 2-adic fractality would indeed be realized in this sense. Besides the basic units for

time and length also their integer multiples can take the role of the basic unit, this of course in accordance with the very notion of fractality.

Small primes would characterize p -adic space-time sheets serving as correlates of intentions. It seems that only relatively small values p , $p = 2$ being the simplest guess, are realized as far as intentionality is considered. The octaves in music realize 2-adic fractality and it might not be an accident that binary mathematics is mathematics of computation.

4 Some Other Aspects Of Consciousness In Relation To Time

The new view about time implies has quite far reaching implications. The notion of 4-dimensional body is the basic concept involved. One can understand long term memories as communications with the geometric past. Sensory perceptions can be seen as memories of magnetic body about the state of the material body in a time scale of a fraction of second. Also some other unexpected symmetries are predicted. Long term memory and precognition seem to be aspects of one and a same phenomenon. The same applies to psychokinesis and retro PK. In fact, both sensory perception, motor action, and memory can be seen as being based on the same mechanism if one accepts that personal magnetic body corresponds to “me”. Libet’s findings about active and passive aspects of consciousness provide empirical support for the notion of magnetic body.

4.1 Passive And Active Aspects Of Consciousness

The division of the aspects of conscious experience to active and passive ones is not so obvious as one might think. Sensory experiencing is more like building a piece of artwork than passive receipt of the sensory input and active processes like healing could be rather passive receipt of negative energy MEs from the patient so that the healee gets in this manner only metabolic energy and does the healing herself. It is also far from obvious whether precognition is passive experiencing of the geometric future or psychokinesis actively affecting it.

The fundamental identification for the active and passive aspects could be in terms of terms of the arrow of time for the sub-self in question. Sequences of state function reduction at the opposite boundaries of sub-CD would correspond to sensory perception and motor action respectively. Which is which would depend on the arrow of time for the CD containing the sub-CD.

A precise theoretical dichotomy, at least apparently analogous to active-passive dichotomy, however exists if one accepts that MEs provide the basic mechanism of remote viewing and intentional action. Negative energy MEs can induce mere entanglement making sharing of mental images possible. This would naturally correspond to the passive aspects of consciousness as far as the receiver of negative energy MEs is considered. The generation of negative energy MEs makes possible remote metabolism at the end of system generating the negative energy ME. The receiver of the negative energy ME, say precognizer would be the passive counterpart whereas its sender, say an area of left cortex suffering from under-nutrition as might be in the case of synesthesia, would be the active counterpart. One must be however cautious here. It is not at all clear whether one can talk about sender/receiver of the negative energy ME since entanglement is completely symmetric process. In the sequel it is assumed that the notion of sucking of negative energy does not make sense.

Low frequency MEs can also contain also high frequency MEs inside them and positive energy MEs of this kind are especially natural for the realization of active aspects of consciousness. Positive energy MEs could directly provide energy to the receiver. They can also induce bridges along which various particles leak between space-time sheets so that basic metabolic activities are induced and controlled remotely.

4.2 Sensory Perception, Motor Action, And Time

TGD view about sensory perception differs dramatically from that of the standard neuroscience in that sensory organs are carriers of basic sensory representations and the magnetic body rather than body or brain is the experiencer with which we can identify ourselves. Magnetic body is also the intentional agent and both motor action, sensory perception, and long term memory which

all involve also intentional elements, are based on the time mirror mechanism (see **Fig. ??** in the appendix of this book). Intentions are represented by p-adic MEs generated at the magnetic body. p-Adic ME is then transformed to a desire about a particular action and represented as a negative energy ME propagating to the direction of the geometric past. Actions are realized as responses to the negative energy MEs as various kinds of neural activities and as a generation of positive energy MEs. A more realistic model involves an entire sequence of this kind of steps proceeding like a sequence of sub-program calls downwards along the hierarchy of the magnetic bodies down to the level of CNS. A good metaphor is obtained by regarding magnetic bodies as bosses in the hierarchy of some organization and CNS as the lowest level ultimately realizing the desire of the big boss.

4.2.1 Sensory organs as seats of qualia

According to the music metaphor, sensory organs are responsible for the music whereas brain writes it into notes by building symbolic and cognitive representations communicated to the magnetic body. Back projection to the sensory organs is an essential aspect of this process and is discussed in [K10]. Sensory perception at the level of magnetic body involves the generation of negative energy MEs entangling with sensory organs involving possibly also brain as an intermediate entangler.

The assumption that sensory organs are carriers of the sensory representations entangling with symbolic representations realized at the level of cortex does not mean any revolution of neuroscience, just adding something what is perhaps lacking [K10].

Neuronal/symbolic level would do its best to symbolically represent what occurs naturally at the level of qualia. Color constancy could be understood as a basic characteristic of color qualia represented symbolically at the neuronal level. Center-surround opponency for the conjugate colors is the neural counterpart for the contrast phenomenon in which the boundary for a region of the perceptive field with a given color carries the conjugate color (black-white opponency associated with the luminance is only a special case of this). The contrast phenomenon at the level of visual qualia could derive from the vanishing of the net color quantum numbers for the electrodes of the retinal color capacitors.

The basic prediction is the presence of the back projection at least in the sensory modalities in which hallucinations are possible. MEs with MEs mechanism is the most natural candidate for realizing the back projection, negative/positive energy MEs would realize the back projection based on quantum/classical communications, and the capacitor model of the sensory receptor can be applied to model photoreceptors and retina. This picture integrates nicely with the various speculations about the role of the ciliary micro-tubules in vision. The obvious question is how the presence and character of the back projection reflects itself in the structure of the sensory pathways and sensory organs.

Basic facts about how gastrulation and neurulation proceed during the development of the embryo, lead to testable hypothesis about the character of the back projection for various sensory modalities. According to the hypothesis, one can speak about “brain senses” and “skin senses” according to whether the back projection is based on quantum or classical communications.

4.2.2 How motor action differs from sensory perception?

There is a deep similarity between sensory perception and motor action in TGD framework, the basic difference being that classical signals propagate in different direction in CNS and in geometric time. Motor action is initiated by the magnetic body by the sending of negative energy to motor organs by generating negative energy MEs, and proceeds by similar processes backwards in the geometric time to the level of brain and magnetic body, very much like an instruction of a boss at the top of organization to the lower levels of hierarchy and induces lower level instructions. The analogy with computer program calls (quantum communications, desires) and their executions (classical signals, actions) is also obvious. Also classical signals from the magnetic body to the body and brain are possible.

Analogous picture applies to sensory perception with motor organs replaced by sensory organs except that the fundamental communications occur to geometric future from biological body to magnetic body via a hierarchy of EEGs. There is however also an active building of sensory percepts by feedback from the magnetic body which selects between quantum superposed alternative

percepts already at the level of sensory organs.

Sensory *resp.* motor imagination differ from sensory perception *resp.* motor action only in that the magnetic body entangles with some higher level of CNS. Therefore there is no danger that imagined motor action would become real or that imagined sensory perception would be experienced as real. This picture is in accordance with the idea of quantum credit card implying maximal flexibility, and with respect to the geometric time would mean that motor actions are only apparently initiated from the brain.

4.3 Long Term Memories And Time

TGD based model of long term memory requires no storage of memories of past to the brain of the geometric now. The memories are in the geometric past as dynamical self organization patterns and subject to changes.

1. In the case of active memory recall the desire to remember is communicated to the geometric past by sharing and fusion of mental images made possible by entanglement. In the case of episodal memories also the memory recall would result in this manner. For non-episodal memories the memory would be communicated from the geometric past using classical communications.
2. In the case of episodal memories active precisely targeted memory recall might be difficult since the entanglement with a correct mental image seems to require good luck. In principle it is possible to select the distance T to the geometric past where the memory comes from by selecting the fundamental frequency of ME. There are huge amounts of information, which is useless unless the person is an artist. Ironically, the loss of cognitive abilities would be compensated by episodal memories providing mental powers making an idiot a genius able to tell whether a given number is prime and to perform extremely complex calculations. A mild variant of the idiot savant phenomenon can be induced artificially by trascranial magnetic stimulation even in ordinary persons [J21]. The miraculous memory feats of synesthetes and idiot savants, and also sensory memories and strange abilities induced by electric and transcranial magnetic stimulation could involve the entanglement of the stimulated brain areas rather than that of magnetic body with sensory representations with brain areas taking the role of sucker of positive energy. In this kind of situation the starving magnetic body could send negative energy sensory MEs to a more distant geometric past and experience episodal memories instead of the sensory input.
3. Classically communicated memories are symbolic and thus the amount of information is minimized. They are also reliable since it is enough for the brain of the geometric past to share the desire to remember. If the desire is communicated to a wide temporal range in geometric past, some self of the geometric past is able to communicate the answer. Context sensitivity is the drawback of this memory mode. Memes defined as sequences of memes defined by sequences of 21 DNA triplets might define what might be called universal language helping to overcome the context sensitivity [K11].
4. Brains could also generate automatically classical signals about often needed declarative memories to the geometric past at various lengths of magnetic flux tubes. The memory recall would require only the tuning to receive the classical signal. This would require an organization of brain analogous to sensory areas so that a particular neuron group is tuned to receive signals from a particular distance to geometric past. One can also imagine a situation in which the communication of the memory from the past occurs as repeated communications over shorter time interval, somewhat like ordinary communications using radio stations receiving and re-sending the message. For instance, classical communications could circulate around the magnetic loops associated with the personal magnetic body or that of Earth's magnetic field much like neural signals in neural circuits. This would make the memory retrieval more reliable. The automatic classical communications could be also involved with the communications by active memory recall. The extreme situation would be the transfer of information from the geometric past like a news about some event in a population via communications between individuals. This mechanism would also establish the memory representation along the entire life span.

4.3.1 Do declarative memories and intentional action involve communications with geometric past?

Communications with geometric past using time mirror mechanism (see **Fig.** <http://tgdtheory.fi/appfigures/timemirror.jpg> or **Fig.** 24 in the appendix of this book) in which phase conjugate photons propagating to the geometric past are reflected back as ordinary photons (typically dark photons with energies above thermal threshold) make possible realization of declarative memories in the brain of the geometric past [K27].

This mechanism makes also possible realization of intentional actions as a process proceeding from longer to shorter time scales and inducing the desired action already in geometric past. This kind of realization would make living systems extremely flexible and able to react instantaneously to the changes in the environment. This model explains Libet's puzzling finding that neural activity seems to precede volition [J6].

Also a mechanism of remote metabolism ("quantum credit card") based on sending of negative energy signals to geometric past becomes possible [K13]: this signal could also serve as a mere control signal inducing much larger positive energy flow from the geometric past. For instance, population inverted system in the geometric past could allow this kind of mechanism. Remote metabolism could also have technological implications.

4.3.2 Episodal memories as time-like entanglement

Time-like entanglement explains episodal memories as sharing of mental images with the brain of geometric past [K27]. An essential element is the notion of magnetic body which serves as an intentional agent "looking" the brain of geometric past by allowing phase conjugate dark photons with negative energies to reflect from it as ordinary photons. The findings of Libet about time delays related to the passive aspects of consciousness [J14] support the view that the part of the magnetic body corresponding to EEG time scale has same size scale as Earth's magnetosphere. The unavoidable conclusion would be that our field/magnetic bodies contain layers with astrophysical sizes.

p-Adic length scale hierarchy and number theoretically preferred hierarchy of values of Planck constants, when combined with the condition that the frequencies f of photons involved with the communications in time scale T satisfy the condition $f \sim 1/T$ and have energies above thermal energy, lead to rather stringent predictions for the time scales of long term memory. The model for the hierarchy of EEGs relies on the assumption that these time scales come as powers $n = 2^{11k}$, $k = 0, 1, 2, \dots$, and predicts that the time scale corresponding to the duration of human life cycle is ~ 50 years and corresponds to $k = 7$ (amusingly, this corresponds to the highest level in chakra hierarchy).

4.3.3 Basic model for memory recall

For the time-mirror model of long term memory the ULF dark MEs must be generated both at the personal magnetic body and in the brain.

1. At the personal magnetic body cyclotron phase transition would give rise to negative energy neutral MEs sucking energy from the biological body of the geometric past. This radiation would be reflected back to the geometric future as positive energy neutral MEs. The response would depend on the state of the brain. Motor action would differ from memory recall only in that it would involve negative energy W MEs inducing exotic ionization at both ends and leading to a physiological outcome. The entanglement via W MEs could induce direct sensory memories relying on sharing and fusion of mental images.
2. The ULF radiation representing the response to the memory recall would correspond to Josephson radiation giving rise to a scaled up dark EEG in the relevant time scale characterized by the level of the dark matter hierarchy. The de-coherence of higher level dark photons to single ordinary EEG dark photon or their decay to EEG dark photons is probably involved with the memory call and would transform the response from the geometric past to ordinary cognitive and emotional input at personal magnetic body.

4.3.4 The time span of long term memories as signature for the level of dark matter hierarchy

Higher levels of dark matter hierarchy provide neat quantitative view about self hierarchy and its evolution. For instance, EEG time scales corresponds to $k = 4$ level of hierarchy and a time scale of 0.1 seconds [K7], and EEG frequencies correspond at this level dark photon energies above the thermal threshold so that thermal noise is not a problem anymore. Various levels of dark matter hierarchy would naturally correspond to higher levels in hierarchy of consciousness and the typical duration of life cycle would give an idea about the level in question.

The level would determine also the time span of long term memories as discussed in [K8]. $k = 7$ would correspond to a duration of moment of conscious of order human lifetime which suggests that $k = 7$ corresponds to the highest dark matter level relevant to our consciousness whereas higher levels would in general correspond to transpersonal consciousness. $k = 5$ would correspond to time scale of short term memories measured in minutes and $k = 6$ to a time scale of memories measured in days.

The emergence of these levels must have meant evolutionary leap since long term memory is also accompanied by ability to anticipate future in the same time scale. This picture would suggest that the basic difference between us and our cousins is not at the level of genome as it is usually understood but at the level of the hierarchy of magnetic bodies [K16, K8]. In fact, higher levels of dark matter hierarchy motivate the introduction of the notions of super-genome and hyper-genome. The genomes of entire organ can join to form super-genome expressing genes coherently. Hyper-genomes would result from the fusion of genomes of different organisms and collective levels of consciousness would express themselves via hyper-genome and make possible social rules and moral.

4.3.5 How to achieve precisely time-targeted communication to and from geometric past?

Negative energy MEs are ideal candidates for sending a signal to the geometric past and inducing entanglement and sharing of the mental image representing the desire to remember. The magnetic flux tubes of the personal magnetic body with sizes measured in light years in turn can act as wave guides along which the negative energy curvilinear MEs propagate along or are parallel to. Also negative energy em MEs are possible since negative energy MEs interact very weakly with the external world in any case. Also the positive energy MEs sent to the direction of the geometric future as a response and representing classically communicated declarative memories would propagate along magnetic flux tubes. The same magnetic flux tube could be used for both communications.

One can consider several variants about how long terms memories are realized as communications between geometric now and geometric past.

1. Mirror model

The original idea was that MEs could be reflected at the ends or kinks of a magnetic flux tube serving as kind of mirrors. The outcome was the mirror model of long term memory in which the signal from the geometric past represented by ME is reflected at the end of the magnetic flux tube of astrophysical size. In the similar manner also the negative energy ME would be reflected. The model was still based on the idea that “me” is the physical body or brain. The basic objections are that there is no convincing identification of the mirrors and there is no guarantee that the mirrored ME returns to the original brain.

2. Loop model

One can also consider the possibility that closed magnetic flux tubes associated with the personal magnetic body could function as wave guides for curvilinear MEs, so that MEs would automatically return to the brain if they propagate while attached to the boundary of a closed magnetic flux tube. Also this model is still based on idea that the size of the personal magnetic body is not much larger than Earth’s size so that one can idealize “me” as brain, at least in the length scale defined by the time span of the long term memories. Furthermore, despite the fundamental similarity between motor action, sensory perception, and memory, the mechanism of long term

memory would differ from the mechanism of motor action and sensory perception. A further serious objection is that MEs parallel to the closed magnetic flux tubes and representing closed topological light rays might not be allowed as solutions of the field equations.

3. Brain and body as time like mirror

If one takes completely seriously idea about “me” as the magnetic body with size at least of order light lifetime which can be regarded as single quantum coherent structure, one ends up to a variant of the model a). First of all, the whole magnetic body becomes the experiencer and classical communications need not be spatially precisely targeted. Secondly, brain and body serve as time like mirrors in the sense space-like reflection is replaced with both spatial and temporal reflection. Negative energy ME characterized by frequency and wave vector is replaced with time reflected positive energy ME: $(-E, -k) \rightarrow (E, k)$ in the reflection. Ideal reflection changes only the sign of the normal component of 3-momentum. If this is the case also now then also the magnitude of energy would be conserved so that the classically communicated memory would be automatically communicated to a correct temporal position in the geometric future.

If the transverse area S of flux tube codes for the temporal distance T to the geometric past by its transverse area ($T \propto S$) and thus by cyclotron frequency scale, the mechanism of long term memory becomes precisely identical with that of sensory perception and motor action. The desire to remember is communicated quantally from the magnetic body to brain along flux tube, and the reply arrives as a classical communication along same flux tube at the fundamental frequency and the reply communicated classically generates cyclotron transitions at the receiver’s end at a correct temporal distance in future. In light of the fractality of consciousness, this model is certainly the unique one and is certainly consistent with the field equations.

The memory mental image communicated classically should reach the temporal position of the 4-D brain, which communicated the desire to remember. High precision communication is not absolutely necessary although it is favored by metabolic considerations: it is enough that the memory is communicated to a time interval containing the temporal position wherefrom the desire to remember was communicated. Memory could even diffuse like an interesting news in a 4-D society formed by mental images in brains at different times.

If MEs are amplified by Alfvén wave resonance (closed magnetic flux tubes or flux tubes with ends), the wave length of ME should correspond to the length of the magnetic flux tube involved. If negative and positive energy MEs are associated with same magnetic flux tubes and the thickness of the magnetic flux tube varies as $S \propto L$, cyclotron transitions occur automatically at a correct temporal and spatial position of the flux tube and the sender of the memory recall receives the answer. In this case however memory is communicated to some time interval in geometric future.

If temporally selective communication is required, the frequency associated with ME must correspond to the same time value for the negative and positive energy MEs involved. A relative precision of $\Delta f/f \simeq 10^{-9}$ is required if the time span of the memory is 10 years and precision about 1 seconds (sensory memories). Of course, the needed precision could be much lower already because the time span of short term memories is of the order of minute. The active loss of memories could result from the refusal or inability of the “mes” of the geometric past to communicate memories or of the “me” of now to generate memory recalls. Later a model of time like reflection which could conserve the frequency with this precision will be discussed.

Second solution to the problem is to have several copies of the memory mental image so that the probability to hit one of them is high. Very probably brain applies this trick. This would explain why the standard model for long term memories seems to work reasonably well.

4. Variants of the time-mirror model

One can consider several variants of the time-mirror model.

1. For the simplest model the MEs involved are more or less linear structures. For classical communications with light velocity the lengths $L = cT$ of the flux tubes would be measured in light years for a typical time span T of long term memory. If the memory recall originates simultaneously from various points of the magnetic body, the reply to the memory recall is received simultaneously by different part of the personal magnetic body in the approximation that the response at the biological body is instantaneous (so that also the received response emerges instantaneously). For EEG phase velocities L would be of the order of the size of

the magnetic body of Earth for typical values of T so that the declarative memory could be communicated also to the magnetic Mother Gaia responsible for the third person aspects of the memory.

2. What is intriguing that for a typical EEG phase velocity v the distance $L_B = vT$ travelled during T corresponds to a wave length $\lambda = L_B = c/f_{high}$ of EEG wave propagating with light velocity. This brings strongly in mind the scaling law of homeopathy and its generalizations [K12], and suggests that the boundary ME corresponds to EEG wave with EEG phase velocity v . This numerical coincidence encourages to consider also time like reflection in which energy is not conserved. The scaling law of homeopathy suggests that low frequency negative energy ME could transform in the reflection to high frequency positive energy ME:

$$f_{low} \rightarrow f_{high} .$$

This transformation could be interpreted in terms of the Alfvén resonance condition $f_{high} = c/L_B$ for a ME propagating in the flux loop of length L_B (recall however the objection against closed topological light rays).

3. Positive energy EEG MEs could propagate with light velocity along the closed loops of personal magnetic body of Earth's magnetic field and return again and again to brain very much like neural signals circulate in neural circuits. This would provide a way to refresh often needed memories. The main theme of [K15] was indeed the fractal correspondence between the structures of the brain and magnetosphere.
4. Fractality suggests that magnetic loops of all possible sizes are involved with classical communications by boundary MEs, even the magnetic loops of the material body serving as templates for neural circuits. The requirement that frequencies are identical for these fractally scaled magnetic circuits could be seen as an entrainment phenomenon. This would predict ultra-slow neural signals serving as correlates for the classical communications of long term memories at brain level. It is indeed known that Ca_{++} have extremely wide velocity spectrum [A2].

The model based on W MEs as induces of motor actions explains these velocities explains these velocities differently. Classical W field depends on the light like longitudinal coordinate and single transversal coordinate. One expects that the maxima for the intensity of W field are the loci around which physiological effects concentrate. These maxima in general propagate in the transversal direction. This velocity could correspond to the velocity of the physiological wave.

4.4 Remote Mental Interactions And Time

If the notion of magnetic body is taken completely seriously, sooner or later comes the realization that not only motor action, sensory perception, and memory, but also various forms of remote mental interactions could be based on essentially the same mechanism. Motor action and memory recall certainly involve the active aspect but so does sensory perception via direction of attention and selection between percepts.

Magnetic bodies are the intentional agents, and accompany even “non-living” targets. The intention of the magnetic body to achieve something is transformed first to a negative energy ME representing the communication of the desire to achieve something to the geometric past by sharing of mental images. Already the sharing of mental images might be enough, as in the case of remote viewing of the geometric past, in special case long term memory. Then the receiver of the negative energy ME, be it lower level magnetic body or material body, tries to realize the desire and generates classical signals. These signals could be also positive energy MEs and could propagate back to the magnetic body as in case of declarative memory recall. They could also propagate to another magnetic body, which would mean that mind-mind interactions are involved.

This unified view means that the distinction between active and passive aspects of remote mental interactions is far from trivial, and it is not so easy to tell where the boundary line between precognition and psychokinesis is. The first realization along these lines was that precognition and long term memory are different aspects of the same phenomenon. Then came the idea that

also PK and retro PK could be seen as different aspects of the same phenomenon if PK can be regarded a generalized motor action in which target becomes effectively part of the body of the psychokinesist.

4.4.1 A possible view about remote viewing

The basic question is whether negative energy MEs are always generated actively by the system in the geometric future or whether also active sucking of the negative energy from the geometric future is possible. The simplest assumption is that the sucking of negative energy is not a sensible concept. The motivation comes from the fact that it seems to be impossible to distinguish between sucking and passive receive of the negative energy since the entangled systems are in a completely symmetric position.

1. *Active and passive aspects*

Whether one can regard remote viewing as active or passive process depends on whether it is geometric past or future which is viewed.

1. If geometric future is viewed, the task of the remote viewer is to tune to the “correct wave length” in order to be able to receive the negative energy ME from the geometric future. This requires that remote viewer tries to get rid of mental images competing for the metabolic resources and tend to mask the viewed mental image. The initiative is possessed by the system in the geometric future sending the negative energy ME. The reaction of the remote viewer realized as classical communications could give rise to PK effect in the target. If the time-mirror mechanism based on induced phase transition is involved also with remote viewing, the reaction of remote viewer would be automatic so that some kind of PK effect would be unavoidable.

One cannot completely exclude the possibility of time reversed classical communications. In ordinary classical communications the high frequency positive energy MEs absorbed by the receiver kicks it to a higher energy state wherefrom it returns to the ground state spontaneously. A system receiving high frequency negative energy MEs inside low frequency negative energy ME can drop to a lower energy state only if the magnitude of the energy is below thermal energy or if the system is analogous to population inverted laser. In the latter case the receiver would not however return spontaneously to the original state unless there is a feed of energy to the system.

2. If the geometric past is viewed, the process is active process and completely analogous to long term memory recall except that negative energy MEs generated by the remote viewer are not received by the brain of the viewer but some other system. Note that now also classical communications are possible and would be analogous declarative memories. These communications might be possible if the target is living system and be based on memetic code using the common vocabulary defined by common memes [K11].

2. *Sharing of mental images*

Since remote viewing by the sharing of mental images does not involve classical communications at all so that one cannot characterize the process in terms of bit currents. There are indeed arguments that if the field patterns of EEG waves were responsible for the remote viewing realized as classical communications, the bit rates required would not be high enough since the frequency defines an upper bound for the bit rate.

Sharing of mental images does not pose any obvious upper bound for the amount of conscious information transferred. Measures for the amount of information contained by mental image could be provided by the number theoretical information measures predicted by TGD approach [K19, K20].

What would be communicated would be more like impressions instead of messages consisting of symbol sequences. The message, say visual perception, would contain huge amounts of irrelevant information. Of course, the mental images could be also cognitive or symbolic representation, say internal speech. The translation of these impressions to language involves cognition and analytic thinking and can lead to misinterpretations. The reports about telepathic communications suggest

that mental images transferred in telepathic communications are fragmented more like sensory and emotional impressions and often what might be regarded as separate “features” of the perceptive field rather than complete percepts. If sensory organs are the seats of the sensory representations, telepathy should thus involve entanglement of the viewer with the brain of the sender containing the symbolic representations. Fragmentation would reflect that fact that brain does for sensory input same as catabolism makes for food.

It is known that the entropy gradients associated with the target correlate with the probability that target is remote viewed [J22]. In TGD framework this can be explained as a basic characteristic of conscious experience [K10]. All gradients, also spatial gradients, such as textures of visual field or gradients of illumination at particular wave length, are transformed to subjecto-temporal gradients and only changes are perceived in accordance with quantum jump as moment of consciousness identification. In TGD Universe the intensities of emotions are proportional to the gradients of entropies associated with various quantum number and zero mode increments and only objects generating strong enough emotional response catch the attention. Targets with low entropy gradients do not generate intense mental images in any perceiver (not necessarily human!), and thus do not generate remote perception by a sharing of mental images.

3. Remote viewing is not only viewer-target phenomenon

Remote viewing does not seem to be only a viewer-target phenomenon but involves many-brained magnetospheric selves receiving information from the brains involved with the typical experiment whose protocol is such that viewer does not know the location of the target. In particular, the ability of the remote viewer to view target about which he knows only coordinates having no significance as such to him but for someone involved with the protocol supports this view [J18]. Also the reported healings induced by prayer groups and meditation groups whose members do not know the healees and even where they are, support the same conclusion [J13]. Thus remote viewing as well as healing might involve multiple entanglement. For instance, healer would be entangled with higher level self in turn entangled with the healee. Fractality suggests that one could apply the wisdom about brain functioning to the modelling of the multi-brained selves. The notion of associations might make sense for instance. The analogy with brain encourages to think that also classical communications by positive energy MEs might be involved and make possible feedback and thus PK.

An interesting practical question is how to characterize the strength of the entanglement by negative energy MEs. The lifetime of the resulting bound state is one such measure. One could guess that this time scale is of the order of the relevant p-adic time scale. Somewhat paradoxically but in consistency with Uncertainty Principle, the duration would be the longer, the weaker the binding energy would be. Second measure is the number of MEs involved. If collective multi-brained selves are involved the number of brains involved and having information about target would be a significant factor.

4.4.2 Sharing of mental images as the basic mechanism of remote viewing

Sharing of mental images does not require neither target nor receiver to be able to communicate symbolically. Therefore the target and receiver could be any living system: animal, plant, even bacterium. In TGD Universe one cannot exclude even “non-living” systems as targets and even sharers of mental images. The remote viewing of non-living targets is indeed possible and in this case either mental images of target or some system perceiving target are shared.

Support for the extreme generality of the sharing of the mental images as a basic mechanism of remote viewing comes from the fascinating experimental discoveries made by Cleve Backster [J2, J9]. These findings have led Backster to introduce the notion of primary perception, which seems to have a natural identification as sharing of mental images.

1. Plants, eggs, and even bacteria are able to have primary perceptions. Backster tells in the interview that even yoghurt got wild when he took a chicken out of refrigerator and began pulling off strips of meat. Plants respond electrically to strong negative emotions and to the violence or death suffered by other living organisms. That primary perception correlates with the strength of emotions conforms with the view that entropy gradients with respect to subjective time, which are indeed identifiable as emotions, measure the strength of perception.

2. Distance does not seem to matter much. Sperm separated by a large distance from its donor reacted when the donor inhaled amyl nitrate. White cells were found to remotely react to the emotions of their donors. Same was found to apply to plants and their owners.
3. Plants and even bacteria seem to have a defence mechanism resembling shock. If bacteria share the mental images of suffering organisms by receiving negative energy MEs sent by them, the shock could be interpreted as resulting from the depletion of positive energy resources (all excited states of population inverted many-sheeted lasers decay to the ground state) or be a mechanism preventing this depletion.

An interesting question is whether humans have lost this ability or is this reaction usually unconscious at our level of self hierarchy and whether human skin could exhibit GSR to say death of other life-forms.

4.4.3 Precognition and memory as different aspects of the same phenomenon?

It is tempting to see precognition and long term memory as different aspects of the same phenomenon involving sharing of the mental image resulting as fusion of mental images by time-like entanglement induced by negative energy ME.

1. This identification would explain why precognition is a rare instance whereas memories would pop up more or less spontaneously. The reason is that precognition means giving energy to the future self whereas memory means receiving it. During wake-up period brain has to utilize its metabolic energy to build sensory representations, to plan and realize motor actions, and cognize. Therefore not much energy is not available unless these activities are silenced. This kind of silencing is indeed a prerequisite for precognition [J18].
2. Sleep state is for metabolic reasons ideal for precognition. During sleep state it is however the larger self resulting as a fusion of brain with some other self which precognizes, so that these precognitions are usually not remembered. It should be however possible to precognize during dreams, especially so during lucid dreaming. The problem is that dreams are forgotten very rapidly unless they are documented immediately. The classic work “Experiment with time” of Dunne provides strong support for the prediction that dreams can be precognitive [J19]. Also Joe McMoneagle has told in his book about heightened precognitive abilities during lucid dreaming [J18]. Probably almost anyone has had dreams which develop logically to the ringing of the alarm clock.
3. In this picture the one who remembers, that is generates negative energy ME, is a natural candidate for the active participant in the process. Therefore precognizer can only calm his/her mind and try to “tune at the same wave length” in order to entangle with the self of geometric future and try to eliminate the mental images that would mask the precognized one and compete for metabolic resources. The tuning to the same wave length has quite literal meaning since the fundamental frequency of ME determined by its temporal duration characterizes what might be called the extension of the memory field. There is indeed evidence for the notion of memory field [J23]. If memory and precognition are aspects of the same phenomenon then also the notion of precognitive field makes sense.

4.4.4 PK and retro PK as essentially same phenomenon?

The ideas that PK is just motor action with target taking the role of the motor organs and motor action involves negative energy W ME leads to a new view about PK and retro PK.

1. Ordinary motor actions are initiated by higher level selves by sucking negative energy from motor organs and the process proceeds upwards in CNS to the direction of geometric past wherefrom classical response comes from. In the case of PK this would mean that psychokinesis would be initiated by psychokinesists by sucking energy from the target by sending negative energy MEs to the target. If this picture is correct, all motor actions, in particular PK, would be by definition retro PK since the reaction would occur in the geometric past always and only the time scale of the time lapse would distinguish between PK and retro PK.

2. One can of course imagine also a situation in which positive energy W MEs are generated and exotically ionize and entangle part of brain with a system located in the geometric future. Certainly this mechanism is not the one favored by the life in jungle. It is also far from obvious whether magnetic body has the needed metabolic energy resources to generate positive energy W MEs.

In the case of non-living targets one can imagine that PK able person is able to transfer the metabolic energy of his own biological body to the target, perhaps by sucking it first to his own magnetic body and sending then to the target. Target could also generate negative energy MEs send most naturally to motor organs or perhaps skin of the psychokinesist. This could induce the flow of various particles to say atomic space-time sheets, where they can induce dissipative effects. This and the universality of metabolism based on zero point kinetic energies forces to consider quite seriously the possibility that the magnetic body of almost any system can be a conscious experiencer or an intentional agent.

3. Not all targets are optimal. Targets should allow the generation of dark plasmoids giving rise to dark plasma oscillations. Capacitor like systems near di-electric breakdown would be optimal in this respect and this kind of systems has been used in PK experiments (this is discussed in [K25]). Targets made of organic material are also favored. If all PK is actually retro PK, PK is possible only if the target is able to provide or receive from some source the metabolic energy needed. Organic or living targets would be optimal but one might expect that living systems have developed immune systems in order to avoid of becoming possessed by alien magnetic bodies. There are indeed reports about PK effects on films which have gelatin as one component [I2]: I have discussed a model for these effects in [K12].
4. MEs can also play a role of mere control function by acting as bridges along which particles can flow between various space-time sheets but not accelerating the charges. The flow of particles between say magnetic flux tubes and atomic space-time-sheets induces a recoil effect and the explanation for the report of Modanese and [H5] [H4] about a new kind of radiation which induces motion of material particles without giving them appreciable energy, supports the view that this recoil effect can induce macroscopic motion. Also the model for the PK effects induced by Russian psychokinesists in charged objects at table near the critical potential inducing discharge leads to the idea that the flow of ions between space-time sheets inducing recoil effects is responsible for PK effect [K25]. Psychokinesist would provide the energy needed for the control of motion but that part of the momentum could come from (say) magnetic flux tubes carrying the ionic supra currents.
5. The idea about long term memory and precognition as different aspects of the same phenomenon does not generalize as such. Psychokinesist would perform (retro) PK to the target while living target could communicate sensory data as a reaction to the motor action coded into Josephson radiation giving rise to generalized EEGs. Hence remote sensing could appear as one aspect of PK and make possible controlled OK in the case that direct sensory input from the target is not available.

In the famous chicken-robot [J26] experiments chicken was imprinted to a robot with the consequence that the robots motion in room coded earlier to a random number sequence changed so that the robot tended to stay near chicken. In this case one could say that chicken performed retro PK in the computer program responsible for generating the random number sequence or sequence itself by generating negative energy MEs. The resulting PK effect on chicken was at the level of chicken brain and provided for chicken metabolic energy. Perhaps the interaction between child and parents involves a similar transfer of energy.

4.4.5 From remote viewing to quantum remote sensing?

Ordinary remote sensing technology is limited by the finite velocity of light making it impossible to remote sense actively objects that are too faraway. Time mirror mechanism (see **Fig. ??**) not only makes it possible to survive utilizing .3-.5 seconds old sensory data but also suggest a technology of active remote sensing based on time reflection at the studied object and thus involving no time lapse, and making possible remote sensing of arbitrarily distant, even astrophysical, objects.

A phase conjugate laser wave would travel to the geometric past and time-reflect back as an ordinary laser wave from an object containing population inverted many-sheeted laser mirrors. If negative energy ME is able to draw some critical number of particles to the ground state, a phase transition to the ground state occurs since the rate for the transition is proportional to the number of particles already existing in the ground state. The only additional condition is the presence of the many-sheeted population reversal. This condition could be satisfied for living matter at least.

Dela-Warr camera [J11] might be based on this mechanism. Even more science-fictionally and a little bit of tongue in cheek, one can consider also the possibility of communicating with the civilizations of the geometric future by using population inverted lasers. Send to the geometric future classical k-bit signals (k harmonics of the fundamental) at p-adic frequencies $f(n, k)$ to tell that we have discovered p-adic cognitive codes, and wait whether the population inverted lasers at these frequencies return to the ground state with an abnormally high rate! One can easily imagine simple codes for communication. For instance, for p-adic length scales corresponding to visible wave lengths the typical number of bits would be 163.

In the technological context remote metabolism would translate to a remote utilization of energy stores making unnecessary the costly transport of the fuel. Only negative energy signal of critical intensity would be required to generate amplified positive energy signal from the geometric past providing the energy instantaneously and over long distances. For instance, the need to carry large amounts of fuel and the limitations posed by the maximal classical signal velocity are the basic problems of the space technology. The technological variant of the remote metabolism might provide at least a partial solution to these problems.

4.5 Some Paradoxes Solved By The New View About Time

In the sequel some paradoxes of modern physics and philosophy of mind related closely to the notion of time, are discussed.

4.5.1 Paradoxes related to quantum physics

The basic paradox is the conflict between the non-determinism of the state function reduction and the determinism of the Schrödinger equation. At a more general level this paradox is the conflict between the subjectively experienced actuality of the free will and the determinism of the objective world. The resolution of this paradox in TGD context is already discussed.

In the context of the deterministic physics, theoretician encounters three rather unpleasant paradoxes.

1. The determinism implies that the unique objective reality corresponds to a single solution of the field equations. The first question is “What determines the initial conditions, say at the moment of the big bang?”. The attempt to answer this question leads necessarily outside the physical theory: one possibility is to postulate anthropic principle. In TGD objective reality changes at each quantum jump and the localization in zero modes and Negentropy Maximization Principle imply a genuine p-adic evolution: therefore the recent objective reality is indeed an outcome of conscious selections.
2. The second paradox encountered by a theoretician is that in principle it is not possible to test a deterministic theory since only single solution of the field equations is realized and a genuine testing would require the comparison of the time developments for various initial data. In practice this problem can be circumvented by assuming the existence of identical sub-systems having very weak interactions with the external world but in principle the problem remains unsolved. In TGD framework the hopping in the space of quantum histories makes possible the conscious comparison of the “solutions of field equations”.
3. A further paradox relates to the dualism between theories and reality. Sooner or later theoretician is forced to ask about in what sense the theories exists. In TGD framework there is no need to postulate any further reality behind the theory. Quantum histories/ WCW spinor fields are what exists, model of reality is the reality. The hopping around in the space of these mathematical structures gives rise to the experiences of the pain and the concepts of toe and stone.

The famous Einstein-Bohr debate was related with the question whether God plays dice or not. In TGD context both were correct in their own ways. Quantum histories are indeed deterministic but God can replace the old quantum history with a new one: perhaps one should not however call this act dice playing but simply an act of free will. Einstein was also an advocate of local realism: this led to Einstein-Podolski-Rosen paradox created by the possibility of quantum entanglement between distant system. In TGD framework local realism holds true at the level of the infinite-dimensional WCW but not at the level of space-time since point like particles are replaced with 3-surfaces.

The phenomenon of dissipation is paradoxical from the point of view of standard physics. It is generally accepted that the fundamental laws of classical physics are reversible whereas everyday reality is manifestly irreversible. Thus the situation is rather schizophrenic. Two worlds, the reversible and extremely beautiful world of the fundamental physics and the irreversible and mathematically rather ugly “real” world, seem to exist simultaneously. The quantum jumps between quantum histories concept solves the paradox and one can understand the dissipative world as an effective description forming an “almost” -envelope for the sequence of reversible worlds (time developments).

4.5.2 Paradoxes related to the theories of consciousness

Chalmers describes in his book “Conscious Mind” [J10] several paradoxes related to the materialistic and dualistic theories of mind. A common denominator for these problems is the assumption that consciousness is a property of a physical state: hence these paradoxes disappear in TGD context. These paradoxes are encountered also in the quantum theories of consciousness identifying consciousness as a property of a macroscopic quantum state, say Bose Einstein condensate.

In the materialistic theories of mind, postulating a unique objective reality, consciousness is an epiphenomenon and free will is necessarily a peculiar illusion and one can always ask why the consciousness is needed at all. Nothing changes in the physical reality if consciousness is dropped away. It is also very difficult to understand how the contents of consciousness are determined by the state of the material world.

In the dualistic theories postulating a unique objective reality (say the theory of Chalmers [J10]), the problems are related to the coupling between matter and mind. The basic problem of the dualistic theories is what Chalmers calls hard problem: how the physical processes in the brain give rise to conscious experience? If the laws of the physics determine the behavior of the system completely then one ends up immediately either with a complete separation of the mind and matter so that our conscious experience tells nothing about the material world or with materialism and epiphenomenalism. One can also consider a non-trivial coupling between matter and “mind like” fields but assuming a deterministic physics one ends up with a situation in which the mind fields are effectively just additional physical fields and consciousness is again redundant.

In TGD framework, which could be called tripartistic, hard problem and other problems of the dualistic theories disappear since there is no need to assign consciousness to quantum history. Moment of consciousness as quantum jump between quantum histories hypothesis allows even to define measures for the information contents of the conscious experience despite the fact that one cannot write explicit formulas for the contents of conscious experience.

4.5.3 Logical paradoxes and concept of time

Many logical paradoxes could be resolved if one assumes that there are two times: geometric and subjective and that the space-time surface providing linguistic representations changes quantum jump by quantum jump. In particular, during the conscious argument leading to the logical paradox!

The objections of Uri Fidelman [J28] against the Platonic vision about reality involve the paradoxes of the cyclic cosmology (one might think that Turing machine in cyclic cosmology might be able to “know” whether it has halted immediately after starting and thus be much more powerful than ordinary Turing machine). Basic paradox is that in cyclic cosmology allowing time travel one can imagine a psychopathic son who murders his mother.

It is interesting to consider this paradox as resulting from identification of the identification of subjective time with geometric time, which I see only as an approximation. In TGD the counterpart

of time travel would be sequence of quantum jumps changing the entire classical history quantum jump by quantum jump and inducing the shift of the space-time region, where the contents of consciousness of time traveller are concentrated, to the geometric past. No paradoxes result since space-time is not a fixed arena of dynamics but changes in each quantum jump.

As a second example one can take the second objection of Uri Fidelman [J28] against Penrose's program known as Berry's paradox.

Non-formalizable theory cannot provide a model of the physical world which includes the brain's cognitive function, since such a model must be lingual, written or spoken. However, such a model implies the following paradox of Berry: Let n be the smallest number which cannot be defined by an English sentence having less than, say, a hundred letters. This number exists, since the number of all possible combinations of a hundred letters is finite. Nevertheless, it has just now been defined by a sentence comprising less than a hundred letters.

Berry's paradox could be understood when the piece of text is seen as inducing a sequence of quantum jumps in which the space-time region at which the argument is represented symbolically changes. For the initial space-time region representing my cognitive state there is indeed smallest number n which cannot be defined by using less than one hundred words (using the English in that space-time!). After reading the statement quantum history is replaced by a new, more complex one in which this number can be defined by using less than one hundred words since a new reflective level of cognitive consciousness has emerged and is represented at space-time level.

This example encourages to think the possibility of replacing the idea of a fixed axiomatic system with a living and dynamically evolving system becoming conscious of new axioms from which new theorems can grow. Mathematician would not be anymore an outsider but an active participator affecting the mathematical system he is studying. For instance, when paradoxical statement represented symbolically becomes conscious in quantum jump sequence, also the context in which it was originally stated changes. This dynamical view about mathematical system could allow to solve antinomies.

4.6 Comparison With The Approach Of Barbour

The comparison of TGD based view about time with that of Barbour might help to understand what distinguishes TGD view from quantum general relativistic view. Barbour has proposed in his book [J17] that time is illusion. Barbour is a proponent of canonically quantized general relativity, where the canonical quantization rules eliminate time completely from the formulation. This reflects that fact that the dynamical arena is the space of 3-geometries rather than 4-geometries. This is also the situation in the super-space approach of Wheeler, which served as an inspirer of the WCW geometry approach in TGD framework. Barbour's conclusion that time is illusion is certainly counter-intuitive but perfectly logical if one identifies time as geometric time and takes canonically quantized general relativity completely seriously.

There are of course objections against this conclusion. General coordinate invariance is a four-dimensional symmetry and the notion of space-time is crucial in all practical applications of general relativity: therefore the disappearance of time from quantum theory tells that something has gone wrong. Indeed, Schrödinger equation and canonical quantizations were derived originally for non-relativistic systems so that the application of the formalism in general relativity might lead to astray. Secondly, the mathematical formalism resulting exists only formally since the naïve generalization of non-linear field equations to infinite-dimensional context fails.

Accepting for a moment the absence of geometric time, one can ask whether the experienced time could have a place in Barbour's universe. If one accepts the notion of quantum jump sequence also the space of 3-geometries, one would indeed have subjective time. In the transition to TGD Universe space-times become 4-surfaces and the geometric time would emerge automatically. The fundamental deviation from the canonical quantization is that the fundamental variational principle means something more than the extremization of the action defining the theory. This led to the notion of preferred extremal as analog for Bohr orbit.

Zero energy ontology (ZEO) was a great step of progress in the development of TGD. Now pairs of space-like 3-surfaces at the boundaries of causal diamond become the basic objects. It is important to notice that preferred extremal property itself in ZEO is unnecessary unless one requires Bohr orbit property: the reason is that for given pair of 3-surfaces at boundaries CD the space-time surface would be unique for deterministic dynamics. In the case of non-deterministic

dynamics situation can change but this seems to relate to hierarchy of Planck constants bringing in new degrees of freedom related to the non-determinism and to super-conformal symmetries acting as gauge symmetries. Bohr orbit property would be space-time correlate for the correlations of the positive and negative energy states at the ends of CD and non-triviality of quantum dynamics so that preferred extremal property would be another name for Bohr orbit property. Therefore it seems reasonable to assume that the notion of preferred extremal indeed makes sense and is needed.

After several guesses what the preferred extremals might be, it became clear that the formulation of the theory in terms of the modified Dirac equation requires the existence of infinite number of deformations of the space-time surface with vanishing second variation of Kähler action. This is nothing but classical correlate for quantum criticality. The interpretation in terms of conformal symmetries is highly attractive and suggests that most of the conserved charges vanish.

Besides allowing to get rid of the infinities of the local quantum field theories, preferred extremal property implies generalized Bohr rules and assigns to given 3-surface (counterpart of 3-geometry) a unique space-time surface. This however requires generalization of the notion of 3-surface since standard form of determinism fails for Kähler action, Even this is not enough for having the psychological time: the localization of conscious experience requires classical non-determinism (which becomes determinism if 3-surfaces are generalized to sequences of 3-surfaces with time like separations). As found, also p-adic physics as physics of intentionality is required to understand the emergence of the psychological time.

5 Cosmology Of Consciousness And Four-Dimensional Brain

The paradigm of 4-dimensional brain is the most important consequence of the Grand Scenario. The non-determinism of the Kähler action (non-determinism is understood here in the conventional sense of the word) is the quintessential, purely TGD based element of the Grand Scenario: without there would not be any evolution, the contents of conscious experience would be diffused around entire quantum histories and there would be no systems with strongly time-localized contents of consciousness. A second key element is p-adic nondeterminism making possible intentionality and cognition.

5.1 Cosmology Of Consciousness

Cosmology of consciousness scenario is inspired by the notion of infinite self hierarchy and by the quantum-classical correspondence principle stating that the fractal structure of the many-sheeted space-time should directly reflect the general structure for the cosmology of consciousness. For instance, the p-adic evolution of consciousness should have its counterpart at space-time level: indeed, there are good reasons to believe that 4-surfaces have decomposition into regions obeying real or finite-p p-adic topology just like WCW has decomposition into real regions and regions D_p labelled by infinite primes characterizing the appropriate functions space topology. Fractality suggests that there are conscious universes within conscious universes and that the experiences of universes involve kind of abstractions about the experiences of the sub-universes they contain. Summation hypothesis for the experiences of selves indeed states just this.

Each self corresponds geometrically to its own subset of space-time sheets, separate conscious cosmology. Mind like space-time sheets are bounded in time direction since they belong inside CDs. p-Adic length scale L_p gives a first guess for the typical duration $T_p = L_p/c$ of the space-time sheet. Even human body could correspond to mind like space-time sheet: time duration would be of order of lifetime. Note however that the visible body might be only tip of iceberg, and it indeed seems that our magnetic body could have size for which light life is natural unit of size. Since selves contain sub-selves with various values of psychological time, the experiences are actually multi-time experiences with respect to both geometric and subjective time. The most natural identification of the psychological time is kind of center of mass coordinate associated with the sensory selves.

If quantum entanglement in the direction of time is a relatively rare phenomenon (it is completely absent in standard theories), entangled mind like space-time sheets correspond to nearly the same value of time so that our conscious experience gets dominant contribution from time

values around the mean value of the time coordinate for our space-time sheet of finite duration. Entanglement in time direction gives rise to multi-snapshot experiences which would resemble vivid long term memories. The interpretation as genuine memories is however not correct. Rather, multi-time experiences with contents coming from geometric past and recent are in question.

The conclusion would be that the entire 4-dimensional space-time is a living system in TGD universe: both the geometric future and past are living and participate in each moment of consciousness. Each moment of consciousness decomposes into infinite number of sub-moments of consciousness of selves in the self hierarchy with the values of psychological time varying from zero to infinity. The value of our own psychological time of roughly 10^{11} years is just an accident. Entire civilizations can live in different geometric times without knowing anything about each other unless they happen to have entanglement in time direction. If they have, the resulting experiences could be interpreted as memories, dreams, religious or mystic experiences or simply as hallucinations. The inhabitants of sufficiently but not sufficiently advanced sub-cosmologies tend to believe that they are the only conscious beings in the Universe, construct their own cosmology and try desperately to understand why the value of cosmological time happens to be what it is and, to certain degree quite correctly, conclude that Anthropic Principle is the only explanation.

The civilizations of past could still exist and participate to each quantum jump. Also the civilizations of future coexist consciously with us. The hierarchy of selves implies that selves have increasingly longer geometric and subjective memories. The hypothesis about infinite primes implies a hierarchy of literally infinite values of psychological time and God like conscious beings with infinitely long geometric and subjective memories is possible if infinite primes. At the top of the hierarchy is the entire universe having infinitely long geometric and subjective memories and integrating all experiences at the lower levels of the hierarchy in single abstracted experience. Note that this picture gives hopes to understand how universe is able to construct theory about itself. Notice also that any theory of consciousness should be able to predict its own discovery and the infinite hierarchy of selves gives good hopes in this respect.

5.2 Communications In Four-Dimensional Society

The idea about four-dimensional society makes sense only if communication between members of this society is possible. It would be even better if communication could occur in “real subjective time”. This seems to be possible in principle as the following arguments show.

5.2.1 Communication method

A simple model for real time communication between societies of the geometric future and past is based on the possibility of space-time sheets of negative time orientation having negative energy density. It seems natural to assume that at least classical signals propagate from geometric future to geometric past along these space-time sheets. As suggested in [K3, K23] “massless extremals” could make possible coherent motion of living systems. It seems that they could make possible also “real subjective time” communications in four-dimensional society.

1. Signals to the geometric future propagate along space-time sheets of positive time orientation. These space-time sheets can correspond to ordinary material space-time sheets but also almost vacuum space-time sheets can be considered. In particular, so called “massless extremals” [K23] are possible.
2. Signals to the geometric past propagate along space-time sheets of negative time orientation. Negative energy massless extremals are the optimal choice as far as classical communication is involved. The reason is that signal propagates with maximal signal velocity and consists of Fourier components with same momentum direction so that the shape of pulse is preserved. Polarization direction at a given point of the massless extremal is constant and depends on the transversal coordinates only. Solution involves two arbitrary functions and linear superposition of parallel Fourier components with identical polarization directions is possible. Therefore all possible pulse shapes are possible.
3. What happens in the communication is following. Sender performs quantum jump in which massless extremal of positive/negative energy is generated representing signal propagating to

geometric future/past. Some standardized alphabet formed by the pulse forms for massless extremals: two basic pulse shapes identifiable as binary digits is the simplest choice. Receiver interacts with the massless extremal purely classically to receive the message and generates a massless extremal propagating to geometric past/future as a reply. The difference between sender and receiver is that sender performs quantum jump whereas receiver just acts purely classically to receive the message.

4. The communication is on-line “real subjective time” communication. There is no need to wait for next billion years for reply and members of cultures separated by billions of light years can have real time chat about their family problems! Also communication with effective signal velocity larger than light velocity becomes possible by using a “radio mast” in the geometric future able to send past-directed signals: the mast receives a signal from the geometric past and sends it to the second receiver in the geometric past.

5.2.2 Anomalies related to spinning astrophysical objects as empirical support for the idea

The proposed communication method could be regarded as mere wild science fiction unless there were some empirical support for the possibility of communication from geometric future to geometric past. In the articles [H8, H3] various anomalies related to spinning objects are reviewed. These anomalies are discussed in [K30]. There are also anomalies related to spinning astrophysical objects. Kozyrev [H2] has conducted astronomical observations using a receiving system of a new type. These observations have been replicated later by other groups [H1]. These anomalies give also support for the possibility of the signal propagation backwards in time.

1. When a telescope was directed at a certain star, the detector positioned within the telescope registered the incoming signal even if the main mirror of the telescope was shielded by metal screens. This indicated that electromagnetic waves were accompanied by some waves not shielded by the metal screens.
2. When the telescope was directed to the true position, the signal became stronger. As if there had been almost instantaneous propagation of signal with velocity billions times greater than the velocity of light!
3. When the telescope was directed to a position symmetrical with respect to the visible position, again signal was detected: the imaginative interpretation was that the signal came from future position of the star!

Leaving aside the objections of a typical sceptic and the question whether the effect is real or not, one can ask whether the concepts of many-sheeted space-time concept and classical Z^0 field could somehow give rise to this kind of effect in strong conflict with the conventional wisdom.

1. Propagating photons (extremely tiny 3-surface glued to macroscopic space-time sheet) affect the space-time sheet and could generate propagating classical Z^0 field causing the effect in the detector. Of course, one cannot exclude the possibility of negative energy photons although the experimental arrangement eliminating the ordinary photons should eliminate also these.
2. The strong signal from the true position could have explanation in terms of a coherent classical Z^0 field of astronomical size. This kind of coherence is forced by the imbeddability requirement and was coined as topological field quantization in [K14]. One can intuitively understand it as follows. In TGD elementary particle is replaced with 3-surface, which can have arbitrarily large size and absolute minimization of Kähler action forces 3-surface to behave coherently like single particle (in case that it does not so, it decomposes into disjoint components!). The results of Kozyrev are not the only evidence for this kind of behavior. Total eclipses of the Sun by the Moon reach maximum eclipse about 40 seconds before Sun’s and Moon’s gravitational forces on Earth align [H7]. If gravity is a propagating force, this 3-body test implies that gravity propagates at least 20 times faster than light. The result is consistent with the assumption that the acceleration of Earth is towards the true instantaneous direction of the Sun now, rather than being parallel to the direction of the

arriving solar photons now. The TGD based explanation is that the changes of the classical gravitational field are not propagating effects but that the classical gravitational field behaves like single coherent whole (it could of course contain also small propagating part).

3. The signal in the symmetric position could indeed come from geometric future. An attractive possibility is that classical Z^0 field propagated along space-time sheet with negative time orientation: for negative time orientation the propagation is expected to occur backwards in time.

There are also reports about the anomalies related to rotated magnetic systems in laboratory scale and these effects are under intensive study (for instance in Faraday Lab in Russia). The TGD based explanation of the anomalies reported in [H6] is developed in [K30]. The model involves in an essential manner the generation of both negative energy space-time sheets and many particle states with negative single particle energies residing at these sheets and some of the observed strange effects involved support the generation of the negative energy particles. The model allows to seriously consider the possibility that even ordinary ions and atoms could have negative energy counterparts.

5.3 The Paradigm Of Four-Dimensional Brain

The cosmology of consciousness implies that each conscious experience decomposes into separate sub-experiences with the values of the psychological time varying from zero to infinity. Furthermore, the experiences are in general multitime experiences both with respect to both geometric and subjective time. This picture forces the paradigm of 4-dimensional brain having profound consequences concerning the understanding of the brain functioning.

The difficult problems related to the understanding of conscious memory recall could trivialize. No separate mechanisms of memory storage or retrieval are needed and the difficult problems related to the interpretation of the stored memories are circumvented. There are two basic types of memories: geometric and subjective memories. Geometric memories provide as simulation for what happened and will happen provided no quantum jumps occur and has occurred and subjective memories tell what actually occurred. Actual memories are indeed known to be creative reconstructions of past and hence it seems that geometric memories are an essential part of construction. The comparison of expectations and actuality made possible by the two memory types gives rise to the emotions involving comparison aspect.

Subjective memory corresponds to immediate short term memory and the only possible identification of the *genuine* long term memories is as subjective memories at the higher level of self hierarchy, where the time span of subjective memory is longer. One possibility is periodic wake-up of sub-selves representing mental images and giving in this manner rise to long term memories: this requires some kind of periodic neural activity giving rise to the same sub-self periodically. Of course, it is not at all obvious whether long term memories are genuine! It is indeed known that long term memories are a result of a creative process and are not reliable. This would suggest that long term memories are actually geometric memories and are reasonably reliable because our geometric past is rather stable under quantum jumping. Of course, we do not usually test the reliability of our long term memories but take them as granted. The notion of mind like space-time sheet allows multitime experiences containing simultaneous contributions from both geometric present and past and the memories of, say, childhood could be genuine multitime experiences.

The “averaging” associated with the subjective memory implies that volition cannot correspond to the quantum jump occurring in the measurement of the density matrix. Rather, volitional activities must correspond to a localization in zero modes, most naturally selections between degenerate maxima of Kähler function. Besides volition associated with the motor activities, also the focusing of attention and even the selection of premises of logical thought very probably involve this kind of selection. The most probable function of the motor nerve pulses is the generation of multi-furcations in an initial value sensitive system between which the choice occurs. Various motor programs correspond to various branches of the multi-furcation. Just as sensory experience, motor activity is predicted to be a top-down self cascade of quantum jumps starting from the level of the entire body. Each selection of the space-time branch creates self inside which subsystems perform quantum jumps as long as self is awake and these quantum jumps in turn lead to even smaller sub-selves: in this manner a precise and flexible coordination and control of the movement involving

volition at all length scales becomes possible whereas in the standard neuroscience picture body would act like a robot with fixed motor programs.

5.4 Geometric And Subjective Memories

TGD predicts two kinds of memories corresponding to two different time developments. There is deterministic (in generalized sense) geometric time development and the non-deterministic subjective time development by quantum jumps. The memories with respect to subjective time are about previous conscious experiences and “real” whereas geometric “memories” are prophecies giving simulation of geometric past and future assuming that quantum jumps do not alter the macroscopic properties of the space-time surface.

A good visualization is following: each quantum jump represents particular geometric memory whereas the heap of these memories gives rise to subjective memory. The comparison between expectations and reality is obviously a central part of mentality and the heap structure of conscious experience implies that this comparison is a basic function of conscious mind not reducible to anything simpler. It is well-known that our memories involve a lot of construction and are more like stories consistent with what we actually have experienced than actual documents of what happened. This suggests that geometric memories, possibly constrained by subjective memories, give rise to the “story” about past.

5.5 Memories With Respect To Geometric Time As Simulations

Geometric memories are about both future and past and are predictions/simulations for what would happen if no further quantum jumps would occur and what would have happened if no quantum jumps had occurred in past. Geometric memories are also about past: we continually make guesses about the sequences of events which could have led to some event and this is nothing but predicting the geometric past. Of course, geometric memories are simulations rather than real memories. Geometric “memories” are real in the classical limit, when the effect of quantum jumps becomes negligible. In classical physics geometric memory is all that is needed to make predictions of past and future. We can indeed predict rather reliably what will happen in the solar system during the next decade. Also the computational approach to mind assumes only geometric memories. p-Adic geometric memories about future give rise to intentionality often regarded as a basic characteristic of conscious mind: beliefs, expectations, plans, etc. can be understood in terms of the p-adic geometric memory of future.

Intentionality manifests itself in many ways: as expectations of future, planning, goals, desires, fears, imagination, disappointments, etc.. The basic element of mentality is the comparison between the expectations of future and what actually occurred. In TGD framework this tension between potential and actual can be understood. The temporal extension of the mind like space-time sheet makes possible expectations of what happens in the future assuming that no quantum jumps occur or at least that quantum jumps do not change the macroscopic space-time. Single quantum jump contains information about this kind of expectations. Subjective memory in turn tells what happened actually. Therefore it seems natural, and this is the only possibility given the fact that it is not possible to know anything about future quantum jumps, to assume that all aspects of intentionality are made possible the predictions of the expected geometric future and past provided by the mind like space-time sheets.

What is nice is that subjective memory makes it possible to compare the expectations with what really occurred since subjective memory is kind of heap of predictions of future arranged with respect to the value of the psychological time. The origin of at least some emotions, which often involve a comparison of what happened and what was expected to happen, is perhaps here. It is quite well possible that all comparisons must be realized as comparisons of the subjective and geometric time developments (it could be that self is also able to compare its sub-selves).

The possibility of this comparison perhaps provides a solution to the paradox raised by the innocent question “How do I know that the me of today is the same as the me of the yesterday? How do I even know that I existed yesterday?”. The solution might be simple: mind like space-time sheets have extension which can be much longer than the duration of the subjective memory. Therefore subjective memories contain information about the geometric me of the yesterday and geometric me of today and since these me’s resemble each other quite a lot, the conclusion is that

also the yesterday's me was a conscious self living in this same body. It is however quite possible that temporal entanglement with higher selves still remembering my past wake-up states is also involved and realized as a formation of join along boundaries bonds/magnetic flux tubes between the mind like space-time sheets of my self and of higher level self. Higher level self could also communicate directly the subjective memories about my existence to me.

5.6 Are Long Term Memories Geometric Or Subjective Memories?

The answer to the question whether long term memories are geometric memories and thus only simulations or genuine subjective memories of higher level self somehow communicated to us, is not obvious.

5.6.1 Long term memories as geometric memories?

Geometric memories realized as multitime experiences involving mind like space-time sheets located around several moments of the geometric time, provide the simplest realization for the long term memories.

1. The model solves the basic difficulties of the neural net models of long term memory. In the neural net models long term memories are represented by synaptic strengths. The problem is that the learning of new memories destroys old memories. In particular, the stability of the childhood memories is difficult to understand. It is also hard to understand how brain knows that the experience represents memory. One cannot avoid the difficulty by saying that novelty detection tells that experience occurs for the first time since the notion of novelty does not make sense if conscious experience contains only information from single moment of geometric time.
2. TGD model is consistent with neural net models and actually generalizes them. Neural net in the spirit of TGD corresponds to brain as system moving in spin glass energy landscape. Self-organization by quantum jumps leads the system to a bottom of an energy valley representing memory. This model is consistent with the fact that there is no upper bound for autobiographical memory. One can also understand how learning occurs. The repetition of an experience means that energy valley becomes a canyon in time direction so that mind like space-time sheets in the geometric past have a large probability to end up to the region representing memory. In particular, reverberating nerve pulse patterns are ideal for representing cognitive long term memories.
3. Highly emotional experiences generate deep valleys and increase the probability of the system of the geometric past to stay at the bottom of valley. This explains why childhood experiences are so stable. In fact, one could identify primitive emotions of pleasure and pain as related to the motion in the spin glass energy landscape. Pleasure and pain could even directly correlate with the sign of the increment of the Kähler function in the hopping motion in the spin glass energy landscape. Note that primitive pleasure and pain are very much like sensory experiences and one could regard them as sensory experiences of brain about its own motion in spin glass energy landscape. This leads to the generalization of the notions of sensory experience and motor action to include the motion in spin glass energy landscape and to a considerably new insight about the meaning of the brain architecture.

There are also perinatal experiences, memories about previous lives and transpersonal experiences having natural explanation in terms of geometric memory realized as multitime experiences associated with mind like space-time sheets located at different values of the geometric time.

Transpersonal experiences suggests that self is dynamical: if prenatal experiences, memories about previous lives and transpersonal experiences are really what they seem to be, the geometric time extension of self should dramatically increase during these experiences.

5.6.2 Long term memories as subjective memories of higher level self?

The natural identification of the immediate short term memory as subjective memory predicts that the life time of a human sensory self cannot be much longer than .1 seconds, the duration of

psychological moment of time. Our long term memories correspond to much longer time interval and cannot thus correspond to our subjective memories. Entire hierarchy of subjective memories is however predicted and a possible model for *genuine* long term memories (whose existence is questionable) is as resulting from temporary entanglement with selves belonging to the higher level of the hierarchy. Also this identification is consistent with the fact that there seems to be no upper bound on autobiographical memory.

Quantum-classical correspondence principle suggests that entanglement could correspond geometrically to temporary flux tubes between the mind like space-time sheets of self and higher level self. Summation hypothesis implies that our genuine long term memories would be sums over a large number of wake-up periods of self in the subjective past of the self. Therefore one could perhaps understand how ageing self gains gradually wisdom from experience: also the identification of the long term memories as geometric memories explains this. It would seem that our self must be able to shift the hierarchy level in order to remember details on one hand and to form abstractions on the other hand and that the detailed memories about the wake-up periods of self are unavoidably lost.

There are however serious counter arguments against this identification.

1. It is not at all clear why the experiences of the higher level selves during entangled state could be ours! For instance, during sleep without dreams entanglement with some higher level self should occur and we do not remember anything about this. Trance is a second example of this: subject person does not remember anything about the trance state.
2. The averaging involved with the temporal binding means that the subjective memories of the higher level selves cannot possess the details of our long term memories.
3. It is not obvious how to understand learning and the role of emotions in learning.

The entanglement with the higher level self is not necessary to have genuine long term memories. One could consider also the possibility that higher level self could somehow communicate the long term memories to the lower level selves. One function of sleep might be the generation of the entanglement with higher selves making in turn possible the communication of genuine memories of subjective past to our mind. This communication could realize these memories as thoughts about the experiences of past realized as nerve pulse patterns regenerating these thoughts. The lack of a precise realization of this mechanism makes the realization of the long term memories as geometric memories much more attractive option.

5.6.3 Long term memories as a communication between now and geometric past

The basic challenge is to identify concrete mechanisms of long term memory recall. According to the idea of magnetic sensory canvas discussed in [K26], the positions of objects of perceptive field are coded by the frequency scale of the magnetic transitions occurring at the magnetic flux tube structures having size of wave lengths associated with EEG frequencies. The slowly varying thickness of the magnetic flux tube codes for the position of the object of the perceptive field.

This encourages to consider the possibility that also the temporal position of the object of perceptive field could be coded in this manner. There are however two difficulties involved:

1. Since the time scales are of order life time T , the needed frequency resolution is $\Delta f/f \sim \Delta T/T$, if the time resolution is ΔT . This requires frequency resolutions of order $\Delta f/f \sim 10^{-8}$ at least and this kind of resolution is certainly not achievable in the neuronal circuits.
2. If ELF MEs (massless extremals) are involved it is difficult to understand how one could circumvent the fact that the ME represents geometrically a light ray escaping from the system. This ray should be reflected somewhere. Kind of mirror would be required. Magnetic flux tubes could serve as this kind of mirror and allow the radiation to travel in zigzag curve in space-time to geometric past.

There is however a much more elegant mechanism of long term memory recall based on MEs. First, of all what makes MEs so interesting from the point of view of long term memories, is that light like selves has a temporal extension, which can be arbitrary long in given rest system.

Secondly, the pairs of MEs resulting when ME reflects from some structure such as magnetic flux tube structure serving as a mirror, provide a TGD based model of long term memories relying on the idea that long term memory recall involves a “question” sent to the geometric past as a classical signal reflected back to brain in a magnetic mirror, and a subsequent quantum entanglement in which the selves of the geometric past and now as well as ME selves entangle to single self so that the self of the geometric now can share the experience of the self of the geometric past. What is so elegant in this mechanism is that there is no necessity of sending the information as a classical signal, only the time like entanglement is needed. In this case the MEs would have a length of order lifetime so that long term memories would be astrophysical phenomena involving magnetic flux tube structures and MEs. The temporal location T of the memory (or rather, shared conscious event) of the geometric past would be coded by the length L of ME: $L = cT/2$. The TGD based notion of time indeed allows geometric time scales of order lifetime to be involved with subjective experiences in psychological time scale of a fraction of second. Certainly this mechanism is completely out of question in standard physics.

6 Time Delays Of Consciousness

TGD based concept of time has rather dramatic implications and it would be important to show that the new time concept indeed solves conceptual problems and anomalies. One should also devise experiments to test the new time concept. Dissipation is the black sheep in the family of theoretical physics and quantum jump between quantum histories concept explains dissipation in elegant manner. Quantum jumps between quantum histories concept together with the notion of self explains also the peculiar time delays of consciousness revealed in the experiments relating to the active and passive roles of consciousness [J14, J6] and described by Penrose in his book [J25]. It is also possible to explain the causal anomalies revealed by the experiments of Radin and Bierman [J7, J8, J12]. TGD predicts “tribar effect” as a general signature for the quantum jump between quantum histories concept.

6.1 Dissipation As Evidence For Consciousness

TGD based picture about time relies crucially on the notion that quantum jumps occur between quantum histories, objective realities. This hypothesis obviously means giving up the materialistic idea about single objective reality behind our experiences. It took quite long time to realize that our everyday experiences reveals directly the occurrence of quantum jumps between quantum histories! The phenomenon of dissipation is paradoxical from the point of view of standard physics. It is generally believed that fundamental laws of classical physics are reversible whereas everyday reality is manifestly irreversible. This leads to a rather schizophrenic situation. Two worlds, the reversible and extremely beautiful world of fundamental physics and the irreversible and the mathematically horribly ugly “real” world, seem to exist simultaneously. Quantum jumps between quantum histories concept solves the paradox and one can understand dissipative world as an effective description forming “almost” envelope for the sequence of reversible worlds (understood as entire time evolutions).

Dissipation can be also regarded as a direct evidence for the presence of the self hierarchy. One can imagine quite spectacular tests for the idea. NMP predicts that self can be in two modes of consciousness: quantum jumps reduce either matter-mind like entanglement or reduced matter+mind-matter+mind type entanglement leading to an unentangled subsystem giving rise to two new self candidates (sub-system and its complement inside self). The first mode corresponds to “whole-body” consciousness and in this mode matter-mind like dissipation in short length scales should be completely absent. The lowered dissipation should reflect itself as lowered metabolism. The measurement of cell level dissipation occurred during meditative states could provide a test for this picture. TGD explanation for the phenomenon of synesthesia [J24] discussed in [K28] relies on the hypothesis that left brain or considerable parts of it get quantum entangled and spends part of time in “whole-body consciousness”. Indeed, synesthesia can involve lowering of left brain metabolism by as much 18 per cent [J24]: this should lead to paralysis if standard wisdom about brain functioning would hold true!

6.2 Strange Time Delays Of Consciousness: Experiments Related To The Active Role Of Consciousness

Libet has carried out classical experiments about active and passive aspects of consciousness [J14, J6]. It has gradually become clear that these experiments can be interpreted as a support for the identification of “me” as the personal magnetic body. The first class of experiments [J27, J6] is related to the active role of consciousness. For example, the human subject moves his hand at free will. What happens is that neurophysiological processes (changes in EEG, readiness potential) start $T_1 = .35 - .45$ seconds before the conscious decision to move the hand whereas the awareness about the decision to move the hand comes $T_2 = .2 - .1$ seconds before the hand movement. Decision seems to be followed by the action rather than action by decision! This is in apparent accordance with the point of view that consciousness is indeed a passive spectator and the act of free will is pure illusion. What is interesting from the p-adic point of view, is that the most plausible estimates for the time delays involved are $T_1 \simeq .45$ seconds and $T_2 = .1$ seconds [J27]. T_1 is very near to the p-adic time scale $T(6, 43) = .4$ seconds and T_2 to the fundamental p-adic time scale $T(2, 127)$ defining the duration of the memetic codon.

One can imagine two explanations for the paradoxical findings. The explanations turn out to be mutually consistent.

6.2.1 The geometric past changes in quantum jump

Quantum jump between histories picture explains the time delays associated with the active aspect of consciousness nicely and also gives an example of two kinds of causalities.

1. The simplest assumption is that the subjective experience of the hand movement corresponds to the moment, when subject person experiences that hand movement occurs.
2. The space-time surfaces (resulting as the final state of quantum jump) associated with the new quantum history differ in a detectable manner from the old quantum history already before the moment of hand movement since otherwise the new space-time surface would contain an instantaneous and discontinuous jump from the initial to final body configuration, which is not allowed by field equations. Same argument applies to the state of brain. $\Delta T \sim .5$ seconds seems to be the relevant time scale.
3. The attempt of the experimenter to be objective means that in an ideal experiment the observations correspond to the new deterministic history in the associated quantum jump and hence experimenter sees neurophysiological processes as the (apparent) cause of the hand movement with respect to geometric time. With respect to the subjective time the cause of the hand movement is the decision of the subject person.

6.2.2 Motor action is initiated from the magnetic body and proceeds to shorter length scales in reversed direction of geometric time

The vision that motor actions are initiated by magnetic body by feeding negative energy to motor organs and proceed upwards in CNS in a reversed time direction is in accordance with the idea of quantum credit card implying maximal flexibility and would mean that motor actions are only apparently initiated from brain. Motor organs send negative energy MEs to get metabolic energy, say to cortex. If there is lapse $\sim .5$ seconds involved then the observed lapse would find explanation. This view concretizes the idea about the editing of the geometric past and is consistent with the more general explanation discussed above.

This view about motor action means that it proceeds from long length scales to short ones whereas in the standard neuroscience view motor motor action would be planned and initiated in the brain and proceed to the level of motor organs, from short to long length scales. This certainly seems to be the case if one looks only the classical communications (say nerve pulse patterns). The extreme coherence of and synchrony of motor activities is however in conflict with this picture: neuronal communications are simply too slow to achieve the synchrony. This has been emphasized by Mae-Wan Ho [I1]. Since quantum communications proceed backwards in geometric time, classical signalling such as nerve pulses from brain to motor organs are actually reactions to the initiation of the motor action from the magnetic body.

6.3 Strange Time Delays Of Consciousness: Experiments Related To The Passive Role Of Consciousness

Libet's experiments [J14] about the strange time delays related to the passive aspects of consciousness have served as a continual source of inspiration and headache. Every time I read again about these experiments, I feel equally confused and must start explanations from scratch.

What is so important and puzzling is that the backwards time referral of sensory experience is so immensely long: about .5 seconds. The time taken for nerve pulses to travel through brain is not more than .01 seconds and the time to arrive from sensory organs is at most .1 seconds (for axon with length of 1 meter and very slow conduction velocity 10 m/s). For the purposes of survival it would be advantageous to have a sensory input with a minimal time delay.

Why then this long delay? TGD inspired answer is simple: the "me" does not correspond to the material body but to the magnetic body associated with the physical body, and is analogous to the manual of electronic instrument, kind of a monitor screen to which sensory, symbolic and cognitive representations are projected by quantum and classical communications. Since the size of the magnetic body is measured using Earth's circumference as a natural unit, the long time lapse results from the finite velocity of light.

The following explanation is a variant of the model of the sensory representations on the magnetic canvas outside the body and having size measured by typical EEG wave lengths. The basic sensory representations are realized at the level of the sensory organs and entangled with magnetic body whereas symbolic representations are either shared as mental images by or communicated classically to the magnetic body. This differs from the original scenario in which sensory representations were assumed to result by classical communications from brain to the magnetic body.

6.3.1 Communications from brain to magnetic body

One must consider two kinds of communications from body to magnetic body corresponding to positive energy MEs generated by at least brain and negative energy ME sent by magnetic body to at least sensory organs. The assumptions are following.

1. Negative energy MEs bound state entangle the magnetic body with the sensory representations realized at the level of sensory organs, and constructed using back projection from brain and possibly also from higher levels. Fusion and sharing sensory mental images is involved. Also the classical communication of memories to magnetic body could be involved with the build up of sensory and symbolic representations at the magnetic body. In both cases sensory representations are memories with the same time lapse determined by the length of the MEs involved, a fraction of second typically if the magnetic body is of an astrophysical size. During sensory and motor imagination magnetic body entangles by negative energy MEs with some higher level of CNS.
2. Symbolic representations in brain can entangle with the sensory representations entangling in turn with the magnetic body so that CNS defines tree like structure with roots corresponding to sensory organs and branches and leaves corresponding to the higher levels of CNS. Direction of attention selects some path along this tree somewhat analogous to the path defining computer file in some subdirectory.
3. Symbolic representations of the perceptive field can be projected to the magnetic body using also classical signalling by positive energy MEs with phase velocity in a good approximation equal to the light velocity. For instance, if perceptive field contains something important, classical signal to the magnetic body could induce the generation of negative energy MEs turning attention to a particular part of perceptive field. Projection to the magnetic flux tubes of the Earth's magnetic field is possible. The spatial direction of the object could be coded by the direction of ME located in brain whereas its distance could be coded by the dominating frequency of ME which corresponds to a magnetic transition frequency which varies along the radial magnetic flux tubes slowly so that place coding by magnetic frequency results. Field pattern could be realized the coding of information to bits in some time scale, perhaps even in the time scale of millisecond associated with the memetic code. Positive energy MEs generated by brain realize the representation and this implies time delay. In the

original model it was assumed that the direction and distance of the object of perceptive field are coded as direction and distance at the magnetic body. The representations are expected to be rather abstract, and it might be enough to perform this coding at the level of magnetic bodies associated with the sensory organs.

6.3.2 Libet's findings

Libet's experiments [J14] about the strange time delays related to the passive aspects of consciousness serve as a continual source of inspiration and headache. Every time one reads again about these experiments, one feels equally confused and must start explanations from scratch. The following explanation is based on the model of the sensory representations on the magnetic canvas outside the body and having size measured by typical EEG wave lengths [K26].

The basic argument leading to this model is the observation that although our brain changes its position and orientation, the mental image of the external world is not experienced to move: as if we were looking some kind of sensory canvas inside cortex from outside so that the motion of canvas does not matter. Or equivalently: the ultimate sensory representation is outside brain at a fixed sensory canvas. In this model the objects of the perceptive field are represented on the magnetic canvas. The direction of the object is coded by the direction of ME located on brain whereas its distance is coded by the dominating frequency of ME which corresponds to a magnetic transition frequency which varies along the radial magnetic flux tubes slowly so that place coding by magnetic frequency results.

According to the summary of Penrose in his book "Emperor's New Mind" these experiments tell the following.

1. With respect to the psychological time of the external observer subject person becomes conscious about the electric stimulation of skin in about .5 seconds. This leaves a considerable amount of time for the construction of the sensory representations.
2. What is important is that subject person feels no time delay. For instance she can tell the time clock shows when the stimulus starts. This can be understood if the sensory representation which is basically a geometric memory takes care that the clock of the memory shows correct time: this requires backwards referral of about .5 seconds. Visual and tactile sensory inputs enter into cortex essentially simultaneously so that this is possible. The projection to the magnetic canvas and the generation of the magnetic quantum phase transition might quite well explain the time lapse of .5 seconds.
3. One can combine an electric stimulation of skin with the stimulation of the cortex. The electric stimulation of the cortex requires a duration longer than .5 seconds to become conscious. This suggests that the cortical mental image (sub-self) is created only after this critical period of stimulation. A possible explanation is that the stimulation generates quantum phase transition "waking up" the mental image so that threshold is involved.
4. If the stimulation of the cortex begins (with respect to the psychological time of the observer) for not more than .5 seconds *before* the stimulation of the skin starts, both the stimulation of the skin and cortex are experienced separately but their time ordering is experienced as being reversed!

A crucial question is whether the ordering is changed with respect to the subjective or geometric time of the subject person. If the ordering is with respect to the subjective time of the subject person, as it seems, the situation becomes puzzling. The only possibility seems to be that the cortical stimulus generates a sensory mental image about touch only after it has lasted for .5 seconds.

In TGD framework sensory qualia are at the level of of sensory organs so that the sensation of touch assignable to cortical stimulation requires back-projection from cortex to the skin. The mental images generated by direct stimulation of cortex could be called cognitive this is created first and takes some time. If the construction of cognitive mental images about cortical stimulation and the formation of back projection takes at least about .5 seconds the observations can be understood. Genuine sensory stimulus starts to build cortical mental image almost immediately: this mental image is then communicated to magnetic body.

For instance, assume that the preparation of cognitive mental image at cortex takes something like .4 seconds and its communication to magnetic body about .1 seconds and that back projection is possible only after that and takes roughly the same time to the sensory organs at skin and back. This would explain the change of time order of mental images.

5. If the stimulation of the cortex begins in the interval $T \in [.25 - .5]$ seconds *after* the stimulation of the skin, the latter is not consciously perceived. This effect - known as backward masking - looks really mysterious. It would be interesting to know whether also in this case there is a lapse of .5 seconds before the cortical stimulation is felt.

If the construction of cognitive mental image about direct stimulation of cortex takes about .4 second, it does not allow the buildup of cognitive mental image associated with the stimulation of skin. Hence the stimulation of skin does not create conscious cognitive or sensory mental image communicated to magnetic body.

6.4 The Experiment Of Radin And Bierman As Evidence For Quantum Jump Between Quantum Histories Concept

The experiments of Radin [J12] and the later experiments by Radin and Bierman [J7, J8] gave evidence for anomalous unconscious emotional responses preceding their cause. Radin monitored the sympathetic and parasympathetic behavior of the autonomic nervous system with skin conductance, heart rate and fingertip blood volume measurements. Subjects were asked to look at a computer monitor and press a button to start a trial. Button press caused the display of a blank screen for five seconds, then a randomly selected calm or emotional picture was shown for three seconds, and this was followed by ten seconds of a blank screen. In three studies, Radin found significant differences in autonomic physiology, most notably skin conductance, *preceding* the exposure of emotional vs. calm pictures. Radin examined a number of possible normal explanations for the result and concluded that they did not apply.

Radin and Bierman interpreted the result of the experiment as evidence for a reversal of the arrow of time. The constancy of the arrow of psychological time is by no means obvious in TGD Universe and one of the basic challenges of TGD inspired theory of consciousness is to understand how the (probably statistical) arrow of psychological time emerges. Moment of consciousness as quantum jump between quantum histories concept provides however an elegant explanation of the effect without any need to assume the reversal of the arrow of psychological time. What is important that one can also avoid the poorly defined concept of effects propagating backwards in time, which is needed in explanations based on quantum state as time=constant snapshot concept.

Consider now the TGD based explanation. In quantum jump deterministic quantum history is replaced with a new one: this means that, not only the future, but also the *past* changes. Therefore, if the mean galvanic skin response of the subject person provides a faithful representation for some aspects of subject person's deterministic quantum history, the entire time record about skin response must change to a new one in any quantum jump. If subject person experiences a highly emotional stimulus, the moment of consciousness is expected to be more intensive than for calm stimulus in the sense that the non-determinism associated with the quantum jump is expected to cause observable effects in a larger space-time volume of the quantum history (represented to a good approximation as quantum average space-time surface geometrically). Therefore also the change of the quantum past is expected to be more dramatic as it indeed seems to be according to the results of the experiment.

At first it might seem that there are no means to test whether the past has changed at the moment of consciousness. The experimental arrangement of Bierman and Radin, although certainly not originally planned to test quantum jumps between histories concept, circumvents in an ingenious manner this difficulty by comparing the skin responses associated with calm and emotional trials. Standard physics, which is based on assumption that there is no signal propagation backwards in time, predicts that the average skin responses before the stimulus should be identical for calm and emotional trials. This is not the case so that the results of the experiments indeed support TGD based world view.

One can in fact imagine even more dramatic test based on a modification of Radin-Bierman experiment. In quantum-mind discussion group Stan Klein [J27] suggested a modification of Radin-Bierman experiment [J7, J8, J12] providing a test for Stapp's and Sarfatti's theories of conscious-

ness [J16, J1]. One could perhaps consider the following further modification of Radin-Bierman experiment so that it would simultaneously discriminate between Stapp's and Sarfatti's theories and TGD.

1. It might be possible for computer to perform a comparison of the response with average calm and emotional responses *before* the subject person A sees the picture and, depending on whether the response is nearer to calm or emotional average response, to print C or E to a computer screen such that the printing result is seen by person B *before* A sees the picture.
2. The theories explaining phenomenon in terms of effects propagating backwards in time (say Sarfatti's theory [J1]) would predict that computer record and the sequence of letters remembered by B are identical and contain both C: s and E: s. According to [J27] Stapp's theory would predict that both computer record and B's memories contain only C: s.
3. TGD predicts that B would *see* only C: s. The concept of subjective memory implies that B also *remembers* of seeing only C: s whereas computer records would contain both C: s and E: s. This would provide dramatic support for quantum jump between quantum histories concept and for the notion of subjective memory.

In TGD framework one can also consider an alternative explanation for the result of Radin-Bierman experiment. If this explanation is correct, the report of B is consistent with the computer record just as in Sarfatti's theory. The argument goes as follows.

1. Given moment of consciousness contains several irreducible sub-experiences besides the experience corresponding to the "real I", which presumably corresponds to "I" able to communicate using language and possessing long term memories. These "I": s are usually collectively identified as subconscious mind. The phenomenon of blind sight and related phenomena [J3] give support for the idea that there is second "I", most naturally at the same level of self hierarchy. One can even imagine entire population of selves at some lower level of self hierarchy giving rise to "Zombi within us" or shortly Z. In the latter case the response of Z is dictated by statistical determinism at the level of ensemble. Deterministic response has definite value in fight for survival.
2. The values of the psychological times associated with these various "I": s need not be same in given quantum jump. Suppose that Z has psychological time slightly larger than the psychological time of the ordinary "I" so that Z sees the state of the world at time $t + \Delta t$ whereas "the real I" sees it at time t in given quantum jump. The order of magnitude for Δt is roughly one second. Assume further that Z is able to assign emotional content to the picture. If the decision about what picture is shown is purely mechanical involving no quantum jump (and hence only effectively random) then Z can perceive the picture before the ordinary "I" perceives it with the result that galvanic response is created. Galvanic response is deterministic in case that Z is an entire population of "I": s.

Some remarks about the model are in order.

1. The criticism against this kind of model is that Z is perhaps not able to assign any emotional content to the pictures. The experiments supporting the existence of Z mildly suggest that Z sees the things "as they are" (for instance Z cannot be fooled by visual illusions) which in turn suggests that emotional response is perhaps not involved.
2. Z could also receive the information about the picture by precognition in principle made possible by the diffuse contribution to the contents of conscious experience coming from entire initial and final quantum histories. If this is the mechanism, one can however wonder why the "real" I is not capable to same so that also "real" "I" would have *conscious experience* about the nature of the picture before seeing it.
3. In case of Kornhuber experiments similar explanation would lead to the veto model: the conscious decision to raise index finger is preceded by the conscious decision of Z to raise it and the "real I" can decide whether to allow various neural processes to continue or not.

4. In principle (probably only in principle) one could test the model by allowing the selection of the figure to be shown to A be determined by a quantum jump rather than by deterministic process. If this quantum jump occurs only very short time before A sees the picture, response should disappear.

An effect resembling Radin-Bierman effect might occur in much more concrete situation. There is a legend about the ability of the short distance runners to anticipate the shot of the starting pistol and start already before the gun shot. Perhaps this really occurs but in the following sense. When short distance runners hear the shot they perform a quantum jump to a new history. For obvious reasons they might have developed a skill to jump to a quantum history at which they started before the gun shot. Whether this effect occurs could be tested by using video camera or some more sophisticated arrangement (gun shot can be accompanied or even replaced by light signal to make the timing precise). What could happen is that the man with the gun honestly claims that the runner started after the shot whereas videocamera tells that runner started before the shot. This effect deserves the nickname “tribar effect” (tribar is the famous non-existing triangle like structure formed from three bars): in its various forms the effect could provide very general hard evidence for TGD based view about space-time.

Notice that the paradox of ping pong game described in the book of Penrose [J25] can be resolved in quantum jumps between quantum histories picture. The problem is that the time delays of consciousness are so long that no conscious action seems to be possible in ping pong game. The resolution is simple. The players can quite well miss the ball time on the old history but perform a jump to a new history: on this history they do not miss the ball thanks to the rapid deterministic reflex action.

7 Good And Evil, Life And Death

In principle the proposed conceptual framework allows already now a consideration of the basic questions relating to concepts like Good and Evil and Life and Death. Of course, too many uncertainties are involved to allow any definite conclusions, and one could also regard the speculations as outputs of the babbling period necessarily accompanying the development of the linguistic and conceptual apparatus making ultimately possible to discuss these questions more seriously.

Even the most hard boiled materialistic sceptic mentions ethics and moral when suffering personal injustice. Is there actual justification for moral laws? Are they only social conventions or is there some hard core involved? Is there some basic ethical principle telling what deeds are good and what deeds are bad?

Second group of questions relates to life and biological death. How should one define life? What happens in the biological death? Is self preserved in the biological death in some form? Is there something deserving to be called soul? Are reincarnations possible? Are we perhaps responsible for our deeds even after our biological death? Could the law of Karma be consistent with physics? Is liberation from the cycle of Karma possible?

In the sequel these questions are discussed from the point of view of TGD inspired theory of consciousness. It must be emphasized that the discussion represents various points of view rather than being a final summary. Also mutually conflicting points of view are considered. The cosmology of consciousness, the concept of self having space-time sheet and causal diamond as its correlates, the vision about the fundamental role of negentropic entanglement, and the hierarchy of Planck constants identified as hierarchy of dark matters and of quantum critical systems, provide the building blocks needed to make guesses about what biological death could mean from subjective point of view.

7.1 Life And Death

There are rather important steps of progress occurred during that last years (I am doing this updating 2015), which allow a more serious consideration of the notions of life and death in TGD framework.

1. NMP and the notion negentropic entanglement imply that state function reductions do not only destroy entanglement but can also create negentropic entanglement for which the density

matrix is projector to a higher-dimensional sub-space of state space. This changes completely the standard rather gloomy view about evolution as approach to maximal entropy. Also now second law holds but for the ensemble entropy which is single particle quantity whereas entanglement entropy characterizes a system with at least two particles. The stable correlation between system and complement becomes information carrier.

A possible interpretation is as an abstraction: the pairs of state in the superposition are instances of the abstraction, concept, or rule. I have christened the negentropic resources as Akashic records. In this view Universe is a gigantic library, which grows all the time. It is not a priori clear whether the information coded to negentropic entanglement is conscious.

The original idea that interaction free measurement generalizes so that it applies to deduce information about negentropic entanglement turned out to be wrong. Negentropic entanglement must be experienced directly. Interaction free measurement can be however used to read memories represented in terms of bits. For interaction free measurement Elizur-Weizman bomb tester is an excellent representation (see <http://tinyurl.com/y9zenssv>) involves state function reduction. The outcome of interaction free measurement now tells whether the bomb can act as quantum measurement apparatus or not (is it active or not) and at idealized limit the state of bomb is not changed (it does not explode).

The only option consistent with the recent formulation of quantum measurement theory in ZEO and based on NMP is that negentropic entanglement is directly experienced as a rule or concept during state function reduction sequences at the same boundary of CD so that no measurement is needed. This option is the only possible one in the recent formulation.

2. TGD Universe is quantum critical. This statement has now an elegant formulation as a hierarchy of quantum criticalities assignable to a fractal hierarchy of sub-algebras of various conformal algebras associated with TGD acting as gauge symmetries, and labeled by effective Planck constants $h_{eff} = n \times h$. The levels of the hierarchy have interpretation in terms of dark matter. The most important algebra of this kind is super-symplectic algebra. The phase transitions increasing $n = h_{eff}/h$ correspond to scalings $n \rightarrow m \times n$ for some integer m and criticality is reduced so that these phase transitions should occur spontaneously. Living systems can be seen as systems trying to stay at the existing criticality. This requires metabolic energy and homeostasis serves this purposed. Eastern philosophies talk about Karma's cycle and the need to preserve ego preventing the spontaneously occurring extension of consciousness.

One can argue that this view about life as a battle against enlightenment is rather cynical. The attempt to stay at quantum criticality should have some deep positive meaning. Maybe the jumping forth and back between criticalities is what gives life its positive meaning and helps to build Akashic records by generating negentropic entanglement. Maybe living systems could be seen as kind of publishing producing systematically replicas of Akashic records could be the deep rationale behind life.

3. ZEO allows a precise identification of self as a sequence of state function reductions at the same boundary of CD. This allows also to understand how the experience about flow of time and arrow of time emerge. One can also formulate precisely the life-time of the system in geometric sense as the increase of the average distances between the tips in the superposition of CDs associated with self. The life-time in subjective sense can be identified as the number of quantum jumps at passive boundary of CD.

The first state function at the opposite boundary of CD means the death of self and rebirth of self at the opposite boundary. NMP forces this first state function reduction and when it occurs for sub-self higher level self interprets it as an act of volition.

4. NMP has become central principle of TGD inspired theory of consciousness. Quite generally, NMP replaces quantum randomness with intentional evolution: Universe has a goal and this is to increase negentropic resources. The analogs of sleep-wake-up cycles in which self and its shadow wake up would be realized in all scales. Can one interpret also human life cycle as on example about this kind of cycles.

The basic questions seem to be following ones.

1. Is me the self defined by my biological body? In this case biological death would mean re-incarnation of me at opposite boundary of CD and life lived in opposite direction of time. Or does my biological body corresponds to my subs-elf/mental image. Me could in this case correspond to my magnetic body or field body having possibly astrophysical size. The death of my biological body would replaced the mental image about biological body with time reversed mental image.
2. A further interesting question is whether there is a continuity of conscious experience in the re-incarnation of self at opposite boundary of CD. We remember something about our dreams. Does this new self have memories about the earlier life?
3. Also NMP raises questions. Can self perform bad deeds or does NMP automatically imply possible deeds increase the negentropic resources. In thermodynamics thermodynamical fluctuations can break second law in some short enough time scales. NMP has structure very similar to second law. Could it be that bad deeds are analogous to thermodynamical fluctuations: possible but present only in short time scales?

Or is the only remaining non-predictability related to the ordinary state function reductions in which outcome is non-deterministic and random. But how can one see the deeds of Hitler as creation of negentropy? His deeds produced a lot of suffering but did they teach for humanity something very importan: Do not do like Hitler?

Perhaps the only reasonable option is that NMP allows but does not force state function reduction to a density matrix which is a higher-dimensional projector. Self can select whether it performs a reduction to this or a lower-dimensional space or even to a ray of Hilbert space. This allows also bad deeds and the optimistic view would be that these bad deeds are analogous to thermodynamical fluctuations.

7.1.1 What is Death

One can interpret ageing in two senses. The ageing with respect to geometric time and the ageing with respect to the subjective time. Before discussing ageing in the sense of geometric time one must specify what one means with geometric time and what one believes its relationship to subjective time to be.

1. There are two geometric times corresponding to the times assignable to space-time surface and embedding space and by general coordinate each of these times can be identified in various number of ways.
2. Geometric time increases in discrete steps and corresponds to sub-sequent scalings of CD size defined by the distance between its tips by integer. One could call this geometric time associated with particle CD/self personal geometric time. Each self/CD defines its own embedding space time and the increase of the proper time distance between the tips of CD is the natural choice for the definition of the age of self. There is also time associated with space-time surfaces. Both time coordinates can be chosen in many ways but symmetry conditions favor certain choices.
3. Subjective time corresponds to the number of the state function reductions already occurred at the passive boundary since the first one. The ratio of subjective age to geometric age measures the number of conscious experiences per geometric time and the larger this number is the longer of the subjectively experience time is.
4. Ageing itself with the biological and spiritual aspects that we know could be seen in two ways. Biological ageing which corresponds to $h_{eff}/h = 1$ sector consisting of ordinary visible matter and second law which follows also from TGD. Variants of second law are expected also for other values of h_{eff}/h corresponding to dark matter and be a manifestation of the non-determinism of state function reduction at ensemble level. Spiritual ageing would correspond to the gradual increase h_{eff}/h and quite literally leading to the increase of the scope of consciousness. The increase would be due to giving up in the fight against spontaneous increase of criticality to keep h_{eff}/h unchanged and allowing the transition to criticality at longer length scales. Eastern thinking would translate this to ego attachment.

There must of course be some point in fighting against the spontaneous increase of h_{eff} and there is. The longer the lifetime of self is, the wiser the sub-selves representing mental images can become by repeated re-incarnations. Ageing means getting wiser! By favoring the generation of negentropic mental images, self can live longer.

5. The challenge is to understand in more detail how biological death as the first state function reduction at the opposite boundary of CD is forced by NMP. This relates to the growth of entropy at the lowest and also other levels by the challenge is to understand the details. The increase of the total negentropy of CD by generation of negentropic mental images can postpone the biological death.

Could it be that a cascade of state function reductions proceeding down to shorter scales from the level of CD cannot anymore produce negentropic entanglement and after that NMP forces the biological death. Since h_{eff} can increase in the first reduction to the opposite boundary of CD, NMP forces this reduction to eventually occur. An interesting question already posed is whether the integer multiples of the original size of CD correspond to especially critical moments for the biological death.

There is present an entropy growth due to the randomness of state function reduction leading to a thermalization or the ensemble of mental images. This would correspond to second law, which still hold true for ensemble entropy. NMP predicts that the negentropy of conscious experience tends to increase and the biological death is only a transformation to some new form of existence. The dark matter hierarchy with levels labeled by the values of Planck constants has become a key element of TGD inspired theory of consciousness and one can imagine that during ageing these levels of existence begin gradually dominate consciousness.

What interests us mostly is obviously the subjective ageing and biological death. What dying person might experience? Is there a continuity of subjective experience or does suffering end with a loss of consciousness. What follows after biological death? How our deeds affect what happens in biological death and to the experiences after the biological death? Here are some possible answers.

1. If biological body corresponds only a mental images of the magnetic body, the only thing that happens in biological death could be that the contribution of biological body to the contents of consciousness disappears so that other contributions usually masked to a high degree by sensory input and motor activities become into full light of consciousness. In fact biological body and magnetic body are 4-dimensional and there are good reasons to expect that it continues to contribute to the consciousness of some self- not necessarily the self which possessed the body. The question is however about what this particular self that I have experiences in biological death and after it.
2. The notion of negentropic entanglement (see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig.** 21 in the appendix of this book) allows to consider an answer to what might happen in biological death from the point of subjective time. Depending on the choices of self which has the dying person as sub-self, dying person generates bound state entropic entanglement with a loss of consciousness or negentropic entanglement accompanied by an expansion of consciousness. What option the higher level self chooses depends on the probability of the size of the contribution of the state with negentropic entanglement.
3. If the dying person has a strong negentropic entanglement with external world, it tends to be preserved in quantum jumps and only a small entropic contribution is present and there is only a small probability to lose consciousness. Another manner to see this is that a sub-self having very entropic sub-selves (mental images) is experienced by self as something unpleasant and by generalized NMP self might want to get rid of this kind of mental image. This would reduce the chances of experiencing an expansion of consciousness. Perhaps death could be seen as the price for sins.
4. One could also argue that although consciousness might be lost it might be not be in any manner different from sleep. It could be gained back in wake-up but as something different from ordinary wake-up consciousness and determined by the 4-D biological and magnetic bodies and the deceased could remember his former life by still existing 4-D body. The

notion of electromagnetic body, when combined with the view about psychological time, allows to consider a general answer to these questions. Magnetic body probably survives the biological death, and since it serves as the sensory canvas, there are all reasons to expect that subjective consciousness continues after the biological death. The contents of consciousness would be determined by the 4-dimensional physical and electromagnetic bodies and the dominating contribution creating the illusion about reality as a time=constant snapshot would be absent. Kind of timeless consciousness would be in question in accordance with the life review experiences associated with NDEs.

5. One can also ask what might be the physical correlate of self after the biological death. The self associated with the biological body should re-incarnated at the opposite boundary of CD associated with it and defined kind of “shadow me”. The 4-D space-time sheet representing self very probably does not disappear in biological death and the 4-D character of the perceptive field suggests that this 4-D body continues to exist as a conscious entity and the sub-CDs of the geometric past representing mental images still exist. Only at the future boundary of CD the flow of 4-D biological body ceases but the sub-CDs representing existing mental images float to the direction of geometric past in the river of time and remain consciousness.

7.1.2 Ageing from the point of view of second law

In standard quantum theory framework not allowing negentropic entanglement self could be regarded as a statistical ensemble of mental images defined by the unentangled final states of the quantum jumps. Since the size of this ensemble increases quantum jump by quantum jump, the approach of this ensemble to thermal equilibrium is unavoidable although living matter has probably invented ways to fight against the second law of thermodynamics. Thus ageing of self means dissipation.

The hierarchy of Planck constants and negentropic entanglement mean deviations from this picture.

1. For higher levels of dark matter hierarchy the dissipation rate is expected to be slower: the naïve expectation is that the rate is inversely proportional to Planck constant.
2. Negentropic entanglement means second exception to the rule and for given CD second law can be broken in time scales shorter than the time scale characterizing CD [K19].

Each p-adic length scale defines its characteristic dissipation rates. In case of a self decomposing into sub-selves the rate of dissipation is sum over the real dissipation rates associated with the nested system formed by the self, its sub-selves, their sub-selves, etc.... The dissipation associated with states of whole-body consciousness can be anomalously small since only negentropic mental images are absent and if there is only one such mental image (or no mental images at all) there is no generation of ensemble entropy. A possible test for this is the study of total rate of metabolism during meditation.

Dissipation causes the ageing of self: getting old at least at the level of biological body would be the price for having self. More concretely, the entropies associated with various distributions of quantum number and zero mode increments increase during ageing so that mental images are gradually blurred. Note that also our self which defines a mental image of a higher level self is blurred. Also biological death, or at least death experience, seems to be unavoidable fate of self.

7.1.3 Ageing and death from the point of NMP

The possibility of negentropic entanglement allows to see ageing from different point of view if NMP is taken as the analog of second law holding in the realm of subjective existence.

1. Ageing as an entropic process could be seen also as a process analogous to the process of getting drowsy and falling asleep but in much longer time scales. Bodily sub-self would not remember anything about these periods in the case that the entanglement was entropic. Also sleep could represent a similar conscious state without bodily mental image and the impossibility to remember anything about this period of consciousness might be simply due to the fact that one can remember something about sleep state only in sleep state. The periods

during which negentropic entanglement prevails would be experienced as enlightenment like experiences. During ageing bodily sub-self would spend more and more time near the critical line at which this kind of phase transition occurs.

2. Ageing could be seen as a process of personal growth generating negentropic entanglement. The negentropic entanglements generated with larger selves would give rise to larger selves and the metaphor “awakening” would thus be much more than a metaphor. Time-like negentropic entanglement would mean longer time span of attention. Person would spend more and more time in extended state of consciousness and in death finally leave the confines of the biological body. Note that person need not, and probably doesn’t, remember anything about the periods of entanglement in which the local topology of self changes. This would make possible the evolution of selves continuing after death to higher levels of conscious existence.

This picture is rather optimistic: one must also consider the possibility that the evolution of self is not always a continuous personal growth! The fact that the individual development of most people seems to be a process of continual abstraction suggests that biological death is only one step in the process of abstractions and that our self consciously experiences the final transition to higher level of existence in biological death.

7.1.4 Why childhood memories are recalled so intensely?

The first manner to see ageing is as a subjective experience: as ageing with respect to subjective time. Our self contains sub-selves representing our memories, sensory input from the geometric now and future plans. At the old age it often happens that childhood memories begin to dominate whereas the recall of more recent memories is gradually lost. Of course, the contribution of future plans becomes also gradually negligible. This suggests that the contents of consciousness for our self can suffer a gradual transformation such that the childhood begins to dominate: of course, this need not happen always. That the childhood dominates is not easy to understand if the memories of the past are stored in the geometric now as assumed in the standard brain science. In TGD framework the very fact that the childhood consciousness is very intense and un-conceptual, explains the dominance of the episodal memories of childhood.

Who is the subjective experiencer in this kind of situation? Is it the old person with vivid memories or a child with some very diffuse ideas about future? The view about psychological time would suggest that the general experience gradually becomes some kind of a 4-dimensional life review such that the very intense childhood memories dominate but that the person in the psychological now is still the only one who can transform intentions to actions effectively whereas the 4-D body of the past is more or less frozen.

7.1.5 Death as disappearance of the mental image representing the biological body?

If one takes seriously the following two assumptions behind the TGD based model of quantum control and coordinate based on the symbiosis of MEs, magnetic flux tube structures, and matter at the atomic space-time sheets, one ends up with rather concrete view about what happens after the biological death. The ultimate sensory representations are realized on the sensory canvas provided by magnetic flux tube structures of similar size, so that we have magnetic body providing sensory representation of the biological body and external world [K26]. Our magnetic self very probably survives in the biological death by the conservation of the magnetic flux.

In this picture the body of after-life body would consists of the magnetic body plus MEs possibly surviving the death of the biological body. The only difference as compared to the life before death would be that the sensory and cognitive mental images representing the biological body (sub-selves) would disappear and the attention of our self would be directed to something else. Possibly to the entire time span of 4-D biological body since sensory input and motor actions at the upper boundary of personal CD are absent. Near death experiences indeed support this view [K3]. In this picture re-incarnation is possible and even plausible and means only that the magnetic flux tube structure representing our bodily self turns its attention to some other biological body and uses it as a sensory and motor organ. This new biological body could be plant, animal, human, or perhaps something else. In this picture the metaphor about biological body as a cloth becomes very concrete.

Since self has an extension with respect to geometric time, it has memories about its earlier history and one could perhaps identify the continuation of self after the death as that self which has the memories of self with respect to geometric time before death. In this extended state of consciousness self could experience the subjective past of the space-time sheet of self and associate it with self's recent mind-like space-time sheet.

7.1.6 Near death experiences

Near death experiences provide a testing ground for the general ideas about what might happen in the physical death. Experiences resembling near death experiences can be produced now in controlled manner in laboratory circumstances for people well and alive and irrespective of their belief structure subject persons tell about light tunnels and meeting of deceased relatives [J4]. These experiences have been found to be therapeutic and are indeed used as therapy to cure severe psychic traumas. Therefore the materialistic explanation as a hallucination associated with dying brain seems to be excluded. Near death experiences involve experiences like being in light tunnel, seeing beautiful and rich landscapes and meeting dead relatives. Also out-of-body experiences are involved. The model of NDEs are discussed in detail in [K25] and here only some brief comments are represented.

The proposed picture about physical death allows a lot of room to interpret these experiences. For instance, OBEs allow two explanations.

1. The first explanation is based on the fact that in TGD based model of sensory representations the magnetic sensory canvas far outside body basically sees the brain in ELF light. This light usually comes from brain and provides a sensory representation for the external world. TGD predicts also a mechanism producing background ELF radiation from the entire body at magnetic transition frequencies and this background would make possible to see the body 3-dimensionally from outside when the sensory input is absent and does not mask this weak contribution. NDE OBEs might correspond to this kind of vision reported also by yogis.
2. The experience looking one's body from outside could mean that some higher level self corresponding to slow EEG waves and higher em selves formed physically by the personnel of hospital in the hospital room begins to dominate. This self could perhaps see patient's body with the combined eyes of the hospital personnel. Indeed, since the sensory input from the biological body ceases, the illusory identification of "me" with the biological body ceases and attention can be directed to this higher level sensory input.

Geometrically the em bodies of our dead relatives would exist in the geometric past and now, perhaps already in a re-incarnated form. This allows several explanation for the experience of meeting dead or living relatives. A very concrete model would be based on electromagnetic bridges formed by magnetic mirrors and connecting us with our relatives and friends. This would make possible for us to see them in ELF light just like we would see ourselves.

The experience about meeting deceased relatives could be also understood as a special kind of geometric memory. Generation of the long term memory means classically looking to a magnetic mirror at classical level and seeing the me of the past in the mirror. It is however possible to see someone else in the mirror since the magnetic flux tube from the mirror could continue to the body of the deceased relative of friend instead of my body. In the usual states of consciousness the sensory input from the psychological now dominates and this contribution is masked. In near death experiences sensory input from the geometric now is diminished and the transpersonal background contribution becomes unmasked.

7.1.7 What after biological death?

Biological death could mean the loss of sub-self representing body image and involve extension of the physical self: this would explain out of body experiences and near death experiences (person near death looking his body from outside). In fact, an attractive hypothesis, motivated by the quantum model of brain, is that the topological field quanta associated with photons generated by EEG currents having size of order Earth by Uncertainty Principle, could correspond to selves in our personal self hierarchy. Also magnetic flux tube structures associated with body and brain

could have similar sizes and serve as a magnetic body [K26]. In biological death these ELF selves could continue to oscillate as Schumann resonances in the wave cavity between Earth's surface and ionosphere interacting with magnetic flux tube structures!

If one believes that even cell sized structures have their own CDs then the primary p-adic length scale defined by the size scale of a large neuron (10^{-4} meters) would correspond to a time scale of the order of the age of the Universe! It seems implausible that these CDs could disappear totally although zero energy ontology in principle allows it.

Biological body is accompanied by magnetic body and radiation body which provide representation for the physical (or better to say, material) body. The latter consists of radiation selves (massless extremals representing topologically rays of light) representing classically the ELF radiation fields generated by EEG currents, one is led to ask what happens for these em selves in biological death. Some of them correspond to resonant frequencies of the em fields in the 80 km thick wave cavity between Earth surface and ionosphere known as Schumann frequencies and one can consider the possibility that that something which might be called soul remains after the biological death and is represented as Schumann resonances.

The most plausible hypothesis is that both ULF MEs and magnetic flux tube structures remaining after physical death together with the 4-dimensional body of geometric past define our self after the biological death. This leads to the following speculative vision about consciousness after the biological death.

1. The transformation of intentions to actions ceases in the biological death so that the dominating contribution of the psychological now to the experience disappears and conscious experience becomes kind of four-dimensional life review in which also the contributions from other bodies (say deceased relatives) appear as unmasked.
2. The geometric past, or rather experiences about it, can be gradually refined but no big changes are possible, so that a totally new life based on different decisions does not seem to be possible. The assumption about totally new life would also lead to paradoxes. On the other hand, the instability of the long term memories suggests that the memories about the past life could be edited. The conscious experience contains also the contribution of the magnetic body continuing to exist.
3. The surviving magnetic body could attach to some new organism which it begins to use as a sensory and motor organ. The re-incarnation would have the memories of the past life as an unconscious background masked strongly by the sensory input and coming clearly conscious only in some altered states of consciousness. The reports about children remembering they previous life could be understood in this conceptual framework. This of course makes one wonder whether young children could remember their past lives. Perhaps someone should ask!
4. ZEO inspired view about state function reduction suggests more concrete view. The new self is generated at the previously active boundary of CD assignable to the biological body and the new life is lived in reversed direction.

7.1.8 Does soul exist in some sense?

An open question is what happens for the space-time sheet (or CD) assignable to self after biological death.

1. Could this space-time sheet or CD be called soul? Does this soul continue drift in light-cone and get attached to some new material system. Or can it disappear in quantum jump? This would not be a reincarnation in the usual sense of the word. The re-incarnation in the usual sense if the word would mean that one has memories about the life of someone whose has lived in past. In TGD Universe this is quite possible since the mechanisms of remote mental interactions are basically the same as the interaction mechanisms making possible for the magnetic body to control the biological body receive information from it.

“Ontogeny recapitulates phylogeny” principle suggests that the evolution of an individual is image for the evolution of the entire universe. Biological death would be only a metamorphosis to some new form of existence, perhaps as topologically quantized classical fields

associated with the biological body. Magnetic flux tube structures having sizes measured in scale of light lifetime are especially promising candidates for the components of electromagnetic body surviving in the death of what is usually identified as the biological body. Some experimental facts lead to rather precise ideas about the geometric representation of our selves and also suggest that our existence continues in electromagnetic form after death [K3].

3. An attractive identification of “soul” would be as negentropic entanglement resources - Akashic records - serving also as a quantum correlate of love and other positive attributes of consciousness. Could this negentropic entanglement become conscious (be read) in repeated state function reductions or is the counterpart of interaction free quantum measurement require for this to happen?

Indirect support for the survival of space-time sheets carrying associated with negentropic entanglement/large h_{eff} after death comes from rather unexpected direction.

1. The phenomenon of phantom DNA suggesting that dark space-time sheets associated with DNA remain in the chamber which contained DNA: in the experiments of Poponin [I3] the signature of phantom DNA is its interaction with laser light at visible frequencies. Phantom DNA would be represented by mind-like space-time sheets with size of at least the wavelength of visible light (10^{-7} meters). The em selves remaining after our death would have consirably larger size! One can however consider the possibility that some detectable interaction between ELF frequency em fields and “phantom brain” (“em soul”) could be possible and make it possible to prove experimentally the presence of em soul!
2. The claimed successes of homeopathy (for phantom DNA and homeopathy see [K36] and [K12]). could also have explanation in terms of the mind-like space-time sheets. Homeopathic drugs are fabricated by a repeated dilution of the active drug so that the concentration of the drug in solution becomes extremely low. The method of fabrication could however imply that final product contains quite many mind-like space-time sheets of the drug molecules. These mind-like space-time sheets might be able to affect the sickness since the mind-like space-time sheets provide a cognitive representation for drug and this mimicry could “cheat” the patient to cure. The law of similarities could have something to do with the mechanism involved.

More concretely, a given quantum transition frequency characterizing the medicine would be represented as ME with length equal to the wavelength associated with the transition frequency. The electromagnetic body of the molecule could be mimicked by liquid crystal water blobs producing similar transition frequencies and thus containing similar MEs in their electromagnetic bodies. The effect of the medicine would be mediated by the electromagnetic body so that the “fake” medicine could indeed cure.

Some support for the extension of self in death is provided by near death experiences (NDEs). For instance, looking one’s body from outside could mean that self is entangled with a larger self formed by the personnel of hospital in the hospital room and sees patient’s body with the eyes of the personnel. This experience could be understood as experience of, say self representing hospital room: in this experience the visual experiences of persons in the hospital room would fuse to the experience experienced by patient entangled with the hospital room. Meeting one’s relatives and elders could mean entanglement with a larger self formed by the selves of dead and living relatives. This larger self could experience the abstracted experiences of dead and living relatives. Also the ability of subjects of surgical operations to occasionally remember about events occurred during unconscious state, supports this view. Magnetic flux tube structures are the most plausible candidates for the “body” remaining in physical death: this point is discussed in more detail in [K3].

7.1.9 Is it possible to get into contact with deceased?

There is a lot of anecdotal evidence consistent with life after death. Near-death experiences are not the only manner to get convinced for life after death. So called eye-movement de-sensitization and reprocessing (EMDR) discovered by Francine Shapiro [J4, J15] induces what could be interpreted as after-death communications.

1. The experiences of subject persons can be induced by this therapy in highly reliable manner: according to [J4] 98 per cent of patients willing to participate the therapy had after death communication experience. It does not matter what the religious convictions of the subject person are and the experiences are actually rather easy to induce. It does not matter if the loss is traumatic or not or whether it is recent or occurred for decades in past.
2. The experiences resemble near death experiences (light tunnels, beautiful landscapes) and involve spiritual contact with the deceased. The EMDR technique involves getting the patient to move his or her eyes in a particular rhythmic fashion while at the same time attending to a particular aspect of the traumatic memory.
3. How EMDR works is poorly understood as yet: possibly the fact that the shifting of eyes leads to increased brain processing is of importance. Notice that rapid eye movements REM are also involved with dreams. A possible explanation is that EMDR experiences could involve communication with the recent selves of the deceased ones located possibly in the geometric recent or past and represented by magnetic flux tube structure and MEs interacting with them.

7.2 Good And Evil

The vision about life as something in the intersection of real and p-adic worlds together with the notion of negentropic entanglement gives hopes for understanding the quantum correlates of evolution and even ethics. The basic principle would be that good deeds generate negentropic entanglement and Negentropy Maximization Principle - perhaps suitably generalized from its original form- would define the basic principle of ethics.

7.2.1 Quantum ethics very briefly

The proposal is that the basic ethical principle is that good deeds help evolution to occur. This proposal can be criticized. Evolution should correspond to the increase of negentropic entanglement. NMP in strong form forces it and in weak form allows it.

1. If strong form of NMP prevails, one can worry that TGD Universe does not allow Evil at all, perhaps not even genuine free will! No-one wants Evil but Evil seems to be present in this world.
2. Could one weaken NMP so that it does not force but only allows to make a reduction to a final state characterized by density matrix which is projection operator? Self would choose whether to perform a projection to some sub-space of this subspace, say 1-D ray as in ordinary state function reduction. NMP would be like Christian God allowing the sinner to choose between Good and Evil. The final entanglement negentropy would be measure for the goodness of the deed. This is so if entanglement negentropy is a correlate for love. Deeds which are done with love would be good. Reduction of entanglement would in turn mean loneliness and separation.
3. Or could one think that the definition of good deed is as a selection between deeds, which correspond to the same maximal increase of negentropy so that NMP cannot tell what happens. For instance the density matrix operator is direct sum of projection operators of same dimension but varying coefficients and there is a selection between these. It is difficult to imagine what the criterion for a good deed could be in this case. And how self can know what is the good deed and what is the bad deed.

Good deeds would support evolution. There are many ways to interpret evolution in TGD Universe.

1. p-Adic evolution would mean a gradual increase of the p-adic primes characterizing individual partonic 2-surfaces and therefore their size. The identification of p-adic space-time sheets as representations for cognitions gives additional concreteness to this vision. The earlier proposal that p-adic-real-phase transitions correspond to realization of intentions and

formations of cognitions seems however to be wrong. Instead, adelic view that both real and p-adic sectors are present simultaneously and that fermions at string world sheets correspond to the intersection of realities and p-adicities seems more realistic.

The inclusion of phases $q = \exp(i2\pi/n)$ in the algebraic extension of p-adics allows to define the notion of angle in p-adic context but only with a finite resolution since only finite number of angles are represented as phases for a given value of n . The increase of the integers n could be interpreted as the emergence of higher algebraic extensions of p-adic numbers in the intersection of the real and p-adic worlds. These observations suggest that all three views about evolution are closely related.

2. The hierarchy of Planck constants suggests evolution as the gradual increase of the Planck constant characterizing p-adic space-time sheet (or partonic 2-surface for the minimal option). The original vision about this evolution was as a migration to the pages of the book like structure defined by the generalized embedding space and has therefore quite concrete geometric meaning. It implies longer time scales of long term memory and planned action and macroscopic quantum coherence in longer scales.

The new view is in terms of first quantum jumps to the opposite boundary of CD leading to the death of self and its re-incarnation at the opposite boundary.

3. The vision about life as something in the intersection of real and p-adic worlds allows to see evolution information theoretically as the increase of number entanglement negentropy implying entanglement in increasing length scales. This option is equivalent with the second view and consistent with the first one if the effective p-adic topology characterizes the real partonic 2-surfaces in the intersection of p-adic and real worlds.

The third kind of evolution would mean also the evolution of spiritual consciousness if the proposed interpretation is correct. In each quantum jump U -process generates a superposition of states in which any sub-system can have both real and algebraic entanglement with the external world. If state function reduction process involves also the choice of the type of entanglement it could be interpreted as a choice between good and evil. The hedonistic complete freedom resulting as the entanglement entropy is reduced to zero on one hand, and the negentropic entanglement implying correlations with the external world and meaning giving up the maximal freedom on the other hand. The selfish option means separation and loneliness. The second option means expansion of consciousness - a fusion to the ocean of consciousness as described by spiritual practices.

In this framework one could understand the physics correlates of ethics and moral. The ethics is simple: evolution of consciousness to higher levels is a good thing. Anything which tends to reduce consciousness represents violence and is a bad thing. Moral rules are related to the relationship between individual and society and presumably develop via self-organization process and are by no means unique. Moral rules however tend to optimize evolution. As blind normative rules they can however become a source of violence identified as any action which reduces the level of consciousness. There is an entire hierarchy of selves and every self has the selfish desire to survive and moral rules develop as a kind of compromise and evolve all the time. ZEO leads to the notion that I have christened cosmology of consciousness. It forces to extend the concept of society to four-dimensional society.

There is an entire hierarchy of selves and every self has the selfish desire to survive and moral rules develop as a kind of compromise and evolve all the time. The newest progress in this evolution is brought by the cosmology of consciousness, which forces to extend the concept of society to four-dimensional society! The decisions of "me now" affect both my past and future and time like quantum entanglement makes possible conscious communication in time direction by sharing conscious experiences. One can therefore speak of genuinely four-dimensional society. Besides my next-door neighbors I had better to take into account also my nearest neighbors in past and future (the nearest ones being perhaps copies of me!). If I make wrong decisions those copies of me in future and past will suffer the most. Perhaps my personal hell and paradise are here and are created mostly by me.

7.2.2 What could the quantum correlates of moral be?

We make moral choices all the time. Some deeds are good, some deeds are bad. In the world of materialist there are no moral choices, the deeds are not good or bad, there are just physical events. I am not a materialist so that I cannot avoid questions such as how do the moral rules emerge and how some deeds become good and some deeds bad. Negentropic entanglement is the obvious first guess if one wants to understand emergence of moral.

1. One can start from ordinary quantum entanglement. It corresponds to a superposition of pairs of states. Second state corresponds to the internal state of the self and second state to a state of external world or biological body of self. In negentropic quantum entanglement each is replaced with a pair of sub-spaces of state spaces of self and external world. The dimension of the sub-space depends on the which pair is in question. In state function reduction one of these pairs is selected and deed is done. How to make some of these deeds good and some bad?
2. Obviously the value of $h_{eff}/h = n$ gives the criterion in the case that weak form of NMP holds true. Recall that weak form of NMP allows only the possibility to generate negentropic entanglement but does not force it. NMP is like God allowing the possibility to do good but not forcing good deeds.

Self can choose any sub-space of the subspace defined by n -dimensional projector and 1-D subspace corresponds to the standard quantum measurement. For $n = 1$ the state function reduction leads to vanishing negentropy, and separation of self and the target of the action. Negentropy does not increase in this action and self is isolated from the target: kind of price for sin.

For the maximal dimension of this sub-space the negentropy gain is maximal. This deed would be good and by the proposed criterion the negentropic entanglement corresponds to love or more neutrally, positively colored conscious experience. Interestingly, there are $2^n - 1$ possible choices which is almost the dimension of Boolean algebra consisting of n independent bits. The excluded option corresponds to 0-dimensional sub-space - empty set in set theoretic realization of Boolean algebra. This could relate directly to fermionic oscillator operators defining basis of Boolean algebra- here Fock vacuum would be the excluded state. The deed in this sense would be a choice of how loving the attention towards system of external world is.

3. A map between between the different choices of k -dimensional sub-space to k -fermion states is suggestive. The realization of logic in terms of emotions of different degrees of positivity would be mapped to many-fermion states - perhaps zero energy states with vanishing total fermion number. State function reductions to k -dimensional spaces would be mapped to k -fermion states: quantum jumps to quantum states!

The problem brings in mind quantum classical correspondence in quantum measurement theory. The direction of the pointer of the measurement apparatus (in very metaphorical sense) corresponds to the outcome of state function reduction, which is now 1-d subspace. For ordinary measurement the pointer has n positions. Now it must have $2^n - 1$ positions. To the discrete space of n pointer positions one must assign fermionic Clifford algebra of second quantized fermionic oscillator operators. The hierarchy of Planck constants and dark matter suggests the realization. Replace the pointer with its space-time n -sheeted covering and consider zero energy energy states made of pairs of k -fermion states at the sheets of the n -sheeted covering? Dark matter would be therefore necessary for cognition. The role of fermions would be to “mark” the k space-time sheets in the covering.

One can make further questions.

1. Could the moral rules of society be represented as this kind of entanglement patterns between its members? Here one of course has entire fractal hierarchy of societies corresponding different length scales. Attention and magnetic flux tubes serving as its correlates is the basic element also in TGD inspired quantum biology already at the level of bio-molecules and even elementary particles. The value of $h_{eff}/h = n$ associated with the magnetic flux

tube connecting members of the pair, would serve as a measure for the ethical value of maximally good deed. Dark phases of matter would correspond to good: usually darkness is associated with bad!

2. These moral rules seem to be universal. There are however also moral rules or should one talk about rules of survival, which are based on negative emotions such as fear. Moral rules as rules of desired behavior are often tailored for the purposes of power holder. How this kind of moral rules could develop? Maybe they cannot be realized in terms of negentropic entanglement. Maybe the superposition of the allowed alternatives for the deed contains only the alternatives allowed by the power holder and the superposition in question corresponds to ordinary entanglement for which the signature is simple: the probabilities of various options are different. This forces the self to choose just one option from the options that power holder accepts. These rules do not allow the generation of loving relationship.

Moral rules seem to be generated by society, up-bringing, culture, civilization. How the moral rules develop? One can try to formulate and answer in terms of quantum physical correlates.

1. Basically the rules should be generated in the state function reductions which correspond to volitional action which corresponds to the first state function reduction to the earlier active boundary of CD. Old self dies and new self is born at the opposite boundary of CD and the arrow of time associated with CD changes.
2. The repeated sequences of state function reductions can generate negentropic entanglement during the quantum evolutions between them. This time evolution would be the analog for the time evolution defined by Hamiltonian - that is energy - associated with ordinary time translation whereas the first state function reduction at the opposite boundary inducing scaling of h_{eff} and CD would be accompanied by time evolution defined by conformal scaling generator L_0 .

Note that the state at passive boundary does not change during the sequence of repeated state function reductions. These repeated reductions however change the parts of zero energy states associated with the new active boundary and generate also negentropic entanglement. As the self dies the moral choices can be made if the weak form of NMP is true.

3. Who makes the moral choices? It looks of course very weird that self would apply free will only at the moment of its death or birth! The situation is saved by the fact that self has also sub-selves, which correspond to sub-CDs and represent mental images of self. We know that mental images die as also we do some day and are born again (as also we do some day) and these mental images can generate negentropic resources within CD of self.

One can argue that these mental images do not decide about whether to do maximally ethical choice at the moment of death. The decision must be made by a self at higher level. It is me who decides about the fate of my mental images - to some degree also after their death! I can choose the how negentropic the quantum entanglement characterizing the relationship of my mental image and the world outside it. I realize, that the misused idea of positive thinking seems to unavoidably creep in! I have however no intention to make money with it!

4. It is difficult to avoid an association with the basic myth of Christianity about the death of God's Son which is said to mean that sins of sinners are forgiven. How could one make sense of this? Or is the Freudian interpretation the only possible explanation? If negentropy increases as self dies, the paradox begins to disappear. God was self and his Son was his mental image, whose death increased the negentropic resources of the Universe and made it better. We are Gods of our mental images and we are mental images of higher level Gods.

7.2.3 Do positively colored emotions allow a representation of Boolean logic?

Weak form of NMP allows the state function reduction to occur in $2^n - 1$ ways corresponding to subspaces of the sub-space defined by n-dimensional projector if the density matrix is n-dimensional projector (the outcome corresponding to 0-dimensional subspace and is excluded). If the probability for the outcome of state function reduction is same for all values of the dimension $1 \leq m \leq n$,

the probability distribution for outcome is given by binomial distribution $B(n, p)$ for $p = 1/2$ (head and tail are equally probable) and given by $p(m) = b(n, m) \times 2^{-n} = (n!/m!(n-m)!) \times 2^{-n}$. This gives for the average dimension $E(m) = n/2$ so that the negentropy would increase on the average. The world would become gradually better. Note that one assumes that there is some preferred basis for the states and these numbers apply when this basis is given.

One cannot avoid the idea that these different degrees of negentropic entanglement could actually give a realization of Boolean algebra in terms of conscious experiences.

1. There should be a mapping of k -dimensional subspaces of n -dimensional space to the fermionic representation of Boolean algebra
2. Could one speak about a hierarchies of codes of cognition based on the assignment of different degrees of "feeling good" to the Boolean statements? If one assumes that the n :th bit is always 1, all independent statements except one correspond at least two non-vanishing bits and corresponds to negentropic entanglement. Only of statement (only last bit equal to 1) would correspond 1 bit and to state function reduction reducing the entanglement completely (brings in mind the fruit in the tree of Good and Bad Knowledge!).
3. A given hierarchy of breakings of super-symplectic symmetry corresponds to a hierarchy of integers $n_{i+1} = \prod_{k \leq i} m_k$. The codons of the first code would consist of sequences of m_1 bits. The codons of the second code consists of m_2 codons of the first code and so on. One would have a hierarchy in which codons of previous level become the letters of the code words at the next level of the hierarchy.

In fact, I ended up with almost Boolean algebra for decades ago when considering the hierarchy of genetic codes suggested by the hierarchy of Mersenne primes $M(n+1) = M_{M(n)}$, $M_n = 2^n - 1$.

1. The hierarchy starting from $M_2 = 3$ contains the Mersenne primes 3, 7, 127, $2^{127} - 1$ and Hilbert conjectured that all these integers are primes. These numbers are almost dimensions of Boolean algebras with $n = 2, 3, 7, 127$ bits. The maximal Boolean sub-algebras have $m = n - 1 = 1, 2, 6, 126$ bits.
2. The observation that $m = 6$ gives 64 elements led to the proposal that it corresponds to a Boolean algebraic assignable to genetic code and that the sub-algebra represents maximal number of independent statements defining analogs of axioms. The remaining elements would correspond to negations of these statements. I also proposed that the Boolean algebra with $m = 126 = 6 \times 21$ bits (21 pieces consisting of 6 bits) corresponds to what I called memetic code obviously realizable as sequences of 21 DNA codons with stop codons included. Emotions and information are closely related and peptides are regarded as both information molecules and molecules of emotion.
3. This hierarchy of codes would have the additional property that the Boolean algebra at $n + 1$:th level can be regarded as the set of statements about statements of the previous level. One would have a hierarchy representing thoughts about thoughts about.... It should be emphasized that there is no need to assume that the Hilbert's conjecture is true.

One can obtain this kind of hierarchies as hierarchies with dimensions $m, 2^m, 2^{2^m}, \dots$ that is $n(i+1) = 2^{n(i)}$. The conditions that $n(i)$ divides $n(i+1)$ is non-trivial only for at the lowest step and implies that m is power of 2 so that the hierarchies starting from $m = 2^k$. This is natural since Boolean algebras are involved. If n corresponds to the size scale of CD, it would come as a power of 2.

p -Adic length scale hypothesis has also led to this conjecture. A related conjecture is that the sizes of CDs correspond to secondary p -adic length scales which indeed come as powers of two. In case of electron this predicts that the minimal size of CD associated with electron corresponds to time scale $T = .1$ seconds, the fundamental time scale in living matter (10 Hz is the fundamental biorhythm). It seems that the basic hypothesis of TGD inspired partly by the study of elementary particle mass spectrum and basic bio-scales (there are 4 p -adic length scales defined by Gaussian Mersenne primes in the range between cell membrane thickness 10 nm and size 2.5 μm of cell nucleus!) follow from the proposed connection between emotions and Boolean cognition.

Hilbert's conjecture relates in interesting manner to space-time dimension. Suppose that Hilbert's conjecture fails and only the four lowest Mersenne integers in the hierarchy are Mersenne primes that is 3, 7, 127, $2^{127} - 1$. In TGD one has hierarchy of dimensions associated with space-time surface coming as 0, 1, 2, 4 plus embedding space dimension 8. The abstraction hierarchy associated with space-time dimensions would correspond discretization of partonic 2-surfaces as point set, discretization of 3-surfaces as a set of strings connecting partonic 2-surfaces characterized by discrete parameters, discretization of space-time surfaces as a collection of string world sheet with discretized parameters, and maybe - discretization of embedding space by a collection of space-time surfaces. Discretization means that the parameters in question are algebraic numbers in an extension of rationals associated with p-adic numbers.

In TGD framework it is clear why embedding space cannot be higher-dimensional and why the hierarchy does not continue. Could there be a deeper connection between these two hierarchies. For instance, could it be that higher dimensional manifolds of dimension $2 \times n$ can be represented physically only as unions of say n 2-D partonic 2-surfaces (just like $3 \times N$ dimensional space can be represented as configuration space of N point-like particles)? Also infinite primes define a hierarchy of abstractions. Could it be that one has also now similar restriction so that the hierarchy would have only finite number of levels, say four. Note that the notion of n-group and n-algebra involves an analogous abstraction hierarchy.

7.2.4 Some questions

There are still many questions that are waiting for more detailed answer. These questions are also a good manner to detect logical inconsistencies.

1. What is the size of CD characterizing self? For electron it would be at least of the order of Earth size. During the lifetime of CD the size of CD increases and the order of magnitude is measured in light-life time for us. This would allow to understand our usual deeds affecting the environment in terms of our selves and their entanglement with the external world which is actually our internal world, at least if magnetic bodies are considered.
2. Can one assume that the dynamics inside CD is independent from what happens outside CD. Can one say that the boundaries of CD define the ends of space-time or does space-time continue outside them. Do the boundaries of CD define boundaries for 4-D spotlight of attention or for one particular reality? Does the answer to this question have any relevance if everything physically testable is formulated in term physics of string world sheets associated with space-time surfaces inside CD?

Note that the (average) size of CDs (, which could be in superposition but need not if every repeated state function reduction is followed by a localization in the moduli space of CDs) increases during the life cycle of self. This makes possible generation of negentropic entanglement between more and more distant systems. I have written about the possibility that ZEO could make possible interaction with distant civilizations [K18]. The possibility of having communications in both time directions would allow to circumvent the barrier due to the finite light-velocity, and gravitational quantum coherence in cosmic scales would make possible negentropic entanglement.

3. How selves interact? CDs as spot-lights of attention should overlap in order that the interaction is possible. Formation of flux tubes makes possible quantum entanglement. The string world sheets carrying fermions also essential correlates of entanglement and the possibly entanglement is between fermions associated with partonic 2-surfaces. The string world sheets define the intersection of real and p-adic worlds, where cognition and life resides.

7.2.5 How the law of Karma could be realized?

The existence of self hierarchy means that our deeds are remembered also after our death at higher level of self hierarchy although only as an abstracted summary. Also the shadow me which is born at the opposite boundary of my personal CD remembers my deeds like a person remembers his dreams just after wake-up.

One can therefore ask whether the law of Karma or something akin to it might be implied by basic principles of consciousness theory.

First of all, self has two life strategies: be a sinner or saint. Sinner is selfish and minimizes the dependence on the environment by avoiding negentropic entanglement. Saint does the opposite and develops love towards surrounding world.

1. Self can fight for the metabolic energy feed giving rise to the self-organization of self. This strategy works as long as self is a young, brisk and arrogant sinner. Sinners are not desirable mental images from the point of view of higher level self since they induce a lot of entropic mental images (pain). This strategy is also in conflict with the possible goal of the higher level self to achieve fusion of its own mental images.
2. Self can attempt to share mental images by quantum entangling its sub-selves with the sub-selves of other, possibly, higher level selves. This mechanism gives rise to quantum metabolism and expanded states of consciousness, favors the generation of social structures, and means fusion of mental images from the point of view of higher level self. The cognitive mental images of the saintlike self are highly negentropic and favored by p-adic NMP.

On basis of these findings the policy for higher level selves looks obvious: try to get rid of the unpleasant mental images represented by sinners. Higher level self could apply this policy for purely selfish reasons: too bad sinners might affect like a poison to the moral level of the higher level self and, since the law of Karma is universal, could eventually lead to the decline of the higher level self to a lower level of the hierarchy: the world would seem to be a tough place also after death!

7.2.6 What “liberation” might mean?

The strong analogies with eastern spirituality encourage to ask whether the TGD inspired quantum counterpart for the concept of liberation might make sense.

1. Quantum-classical correspondence suggests that the endless evolution at the level of the entire universe corresponds to endless evolution at the level of individual so that the notion of liberation would make sense only as kind of transformation to a higher level of consciousness.
2. In the real context selves having only single mental image or no mental images at all are in state of “oneness” and experience no divisions and separations since the analysis process represented by state function reductions and self measurements is absent. This kind of state realized at the level of field body is a possible candidate for enlightened state. Certainly it cannot last forever.
3. Liberation experience might also relate to the experience of “cosmic consciousness”. Most naturally a generation of negentropic entanglement fusing self to a self at higher level of self hierarchy. The fear about the loss of consciousness is what gives self an ego, since ego is something which can be lost. This can happen via the generation of entropic bound state entanglement with some other system. This can happen for any subsystem of Universe but not for the entire Universe enjoying an eternal state of consciousness. The state of cosmic consciousness thus means being a self without ego. The counterpart for this would be negentropic entanglement. Leaving aside the question whether we are able to experience ideal cosmic consciousness, one can consider the possibility that even human beings could achieve a state of consciousness in which the loss of consciousness is highly un-probable and that this loss of ego is synonymous with the experience of liberation.

The term “cosmic consciousness” looks somewhat pompous notion to anyone identifying himself with his suffering biological body and it would be certainly very difficult to sell this concept to a neuroscientist. The notion of magnetic body, the hierarchy of Planck constants, and the identification of quantum gravitational bound states in terms of astrophysical quantum coherence assignable to gravitational Planck constant, allow to take this notion seriously. In ZEO the arrow of geometric time can change so that finite light velocity does not prevent instantaneous communications over cosmic distances so that communications with life forms in distant galaxies become possible. I have considered a concrete model for what might be involved in [K18].

7.3 About God Theory Of Bernard Haisch

I have found that the best manner to learn about TGD is to read books about other theories, and after many years at the border of basic survival I now have opportunity to do this thanks to some generous people making this possible.

Just now I have been reading Bernard Haisch's book "The God theory" (see <http://tinyurl.com/yaa94c64>) [J5]. Haisch himself is an astrophysicist who might have become priest. The book discusses the possibility of spirituality consistent with physics. It also discusses Zero Point Energy (ZPE) hypothesis and the idea that inertia might emerge from vacuum fluctuations of various fields.

I agree in many respects with Haisch's vision about possibility to build bridge between fundamental physics and spirituality. The new view about spirituality requires that a lot of horrendous stuff of religions (such as eternal purgatory, the sadistic God of Old Testament killing his own son, blind belief in dogmas, etc...) is thrown away. Where I disagree with Haisch is the notion of ZPE but think that I understand why he wants ZPE. In TGD all that can be done using ZPE can be replaced with zero energy ontology (ZEO) to achieve the possibility of re-creation without breaking of conservation laws: without ability to generate new sub-Universes God would be rather powerless creature. I also disagree with the idea that inertia follows from zero point fields although again I understand the underlying motivations of the proposal as relating to a genuine problem of General Relativity. This problem also inspired TGD.

Haisch lists three questions usually regarded as highly non-scientific. Is there really a God? What am I? What is my destiny? As I started to build theory of consciousness, these questions began to make more and more sense also to me. One must be however ready to give up some dogmas such as God as a sage with white hair and long beard, the idea that we are nothing but our neurophysiology generating a brief flash of light in infinite darkness, and the belief that heat death dictated by second law is the eventual fate of the universe as whole.

7.3.1 Putting Haisch in box

When thinkers happen to encounter genuine thinking they want to classify it in order to feel safe. For safety reason some of us also debunk the new idea. The first classification is philosophical. I use three boxes for this purpose (safety reasons). The first box has label "monism". It contains two smaller boxes. "Materialist" contains thinkers accepting only third person view as an acceptable - objective - view about the world. I close to "Idealist" those thinkers who accept only the first person view as fundamental. Most of my colleagues are happy to live in the box "Materialist". The second box has label "Dualist" and contains thinkers accepting both first and third person views - also this box decomposes to smaller boxes depending on how closely the first and third person views are assumed to be related: if the correspondence is exactly 1-1 then the view reduces to materialism. To the third box - "Miscellaneous" - I put the others and live also myself in this box.

Haisch performs the classification himself and completely voluntarily chooses the box "Idealist". Hence consciousness is fundamental form of existence for him. In TGD framework both first and third person perspectives are tolerated: consciousness is however in quantum jump between quantum superpositions of objective realities identified as zero energy states and does not define another world as it does in dualistic theories. As a matter of fact, in TGD several ontological levels are accepted: geometric existence at space-time and embedding space levels in real and various p-adic versions, existence as zero energy states identified as spinor fields of world of classical worlds (WCW) and subjective existence as quantum jumps.

7.3.2 Universe as God

Haisch postulates God as an infinite intelligence. We are God's eyes and ears through which God experiences her (no reference to gender here) own creation. Haisch's God is not the Newtonian clock-smith who creates deterministic universe and then forgets it completely. This God is free to create universes with he chooses freely using her infinite intelligence. This God is also somehow outside the realm of space-time.

The possibility of universes with different laws of physics inside each of them brings in mind inflationary cosmology, multiverse, and the landscape of M-theory. Haisch indeed takes inflationary

scenario and multiverse idea rather seriously and also talks about superstrings. The landscape of string theory is catastrophe from the point of view of physics but would fit with the idea about God who can freely decide about the laws of physics in the limits of mathematical consistency. But what mathematical consistency means? Have M-theorists really thought about this?

What about TGD? In TGD framework nothing prevents from calling conscious selves gods since free will is genuine and the essence of creation. Thus God is replaced with an infinite hierarchy of god like entities. Nothing prevents from calling the entire Universe as God, which is re-creating itself in every quantum jump. This God has us as mental images or to be more precise: as mental images of mental images of..... of its mental images. The sequence could be rather long!

Concerning the laws of physics the situation in TGD framework. The surprising outcome already from the geometrization of loop spaces is that geometry of the infinite-dimensional world of classical worlds (WCW) is expected to be unique if it consists of 4-D surfaces of some higher-dimensional space. This comes from mere mathematical existence requiring the WCW metric to have infinite-dimensional group of isometries (generalization of various conformal symmetries of super string models). This means that also physics is unique just from its existence. As a matter fact, in TGD there is no need to assume any physical existence behind mathematical existence since consciousness is in quantum jumps. Space-time dimension and the choice embedding space are forced by very general mathematical conditions closely related to the structure of classical number fields. Four-dimensional Minkowski space and space-time dimension four are forced by the condition of maximal symmetries needed for the existences of WCW geometry.

Inflation in TGD framework is replaced with quantum criticality making the Universe maximally sensitive perceiver and motor instrument. Quantum criticality means absence of scales (or actually discrete hierarchy of them) and the flatness of 3-space (dimensional curvature scalar vanishes) is the correlate of quantum criticality in cosmology. The inflaton field producing via its decay matter is in TGD framework replaced with monopole magnetic fluxes assignable to magnetic flux quanta which near Big Bang correspond to what I call cosmic strings. The decay of magnetic energy of flux quanta to particles produces matter and radiation. The basic difference to string landscape is that standard model symmetries apply in all these sub-cosmologies although there are dynamical parameters distinguishing between them. Hence TGD is highly predictive theory. Even God must bow to the laws of mathematics. TGD space-time is many-sheeted and one has Russian doll cosmology natural also in inflationary scenarios.

In superstring theory the landscape problem forces to assume anthropic principle: the fact that we exist becomes the basic guide line when we try to identify the particular universe in which we happen to live. In TGD framework the evolution implied by Negentropy Maximization Principle (NMP, [K19]) stating that the conscious information gained in quantum jump is maximal, implies evolution. Evolution gradually fine tunes the values of various parameters so that they generate maximal intelligence. This implies that our existence indeed fixes the values of various parameter very precisely. Of course there are some parameters such as Kähler coupling strength (analogous to critical temperature), whose possible values are dictated by quantum criticality. Note that NMP challenges second law as a universal law - at least a generalization is required in ZEO - and it is now clear that the recent view about universe neglects completely the huge negentropy sources associated with the negentropic entanglement assignable to magnetic flux tubes carrying dark matter. In human scale these resources - “Akashic records” - give rise to memories and plans of future, ideas, ...

7.3.3 The purpose of lifes

Haisch adopts the vision about endless sequence of reincarnations as a kind of “life-school” in which one transcends life by life to higher levels of consciousness - to upper class in school (and sometime to same or even to lower one).

This vision could have rather concrete realization in TGD framework. In the average sense the average size scale for personal causal diamonds (CDs) in their quantum superposition grows in a given quantum jump, and a biological death now and then does not stop this process. New sub-CDs also pop up and mean creation of new small sub-Universes which began to evolve. Asymptotically the size of the personal CD approaches infinity - asymptotic Universe, asymptotic Godness!

Biological death would not mean the end of consciousness, only a transformation to a new level: perhaps higher, perhaps same, or maybe even lower. This depending on the Karma - the

law of action and reaction at spiritual level as Haisch puts it - that we have gathered by our deeds. By doing bad deeds reduce our level of consciousness guaranteeing the return to a lower level in hierarchy. This has quite concrete quantum physical correlate: reduction of the effective Planck constants reducing the quantal size scales of the magnetic flux tubes connecting as bridges of attention to the rest of the world and reducing thus quantum coherence lengths and times characterizing us. It also reduces our long range goals from those dictated by a mission to short range goals dictated by opportunism.

7.3.4 What could happen in biological death?

“What is my fate?” is one of the questions of Haisch. A more concrete formulation for this question is “What happens to the magnetic body in biological death?”. TGD framework provides the tools for a glass pearl game around this question.

It would not be too surprising if at least some upper layers of this onion-like structure were preserved. NMP might guarantee the approximate conservation of the entire magnetic body since its braiding serves as a correlate for negentropic entanglement (see **Fig.** <http://tgdtheory.fi/appfigures/cat.jpg> or **Fig. ??** in the appendix of this book) defining “Akashic records”, a kind of cumulative collective wisdom having as a counterpart Sheldrake’s morphic fields defining among other things also species memory.

What it means that in 4-D sense (contents of consciousness are from 4-D embedding space region: either boundary of CD in given scale) also our biological body still exists as sub-CD of the larger CD we continue to exist subjectively? Only the sensory input and motor output consciousness has ceased in biological death.

Does my biological body continue its life in reversed direction of embedding space geometric time? The answer is negative if one relies on the assumption that the arrow of embedding space time changes and the folded bath towel argument for the arrow of 4-D time defined by thermodynamical entropy holds true: my body would continue becoming older than it was at the moment of death. Not very plausible or desirable scenario!

NMP requires that negentropic entanglement is generated at the moment of biological death and adds to existing negentropic entanglement defining “Akashic records” about previous life conserved in good approximation. What I painfully learned during my lifetime is not waste! Attention is directed to some target generates negentropic entanglement. It has braiding of magnetic flux tubes connecting the attending system to the attended one. Reconnection is the mechanism for building flux tube bridges between the systems.

Tibetan book of dead supports what NMP suggests: I direct my attention somewhere else from my biological body which has become rather uninteresting. The new target of attention could be some new brisk young life form not yet caught the attention (almost anywhere in planet or even elsewhere but inside my personal CD: my magnetic body is big with size scale of - as I hope - about one hundred light years at least!). My new life would proceed in opposite direction of embedding space time (recall that two subsequent quantum jumps create zero energy states with opposite arrows of embedding space geometric time). Maybe I remember the teachings of Tibetan book of dead and manage to direct my attention to a higher level in self hierarchy, larger CD, representing perhaps a collective level of consciousness.

If one takes fractality seriously, the death of civilizations and cultures could be a process analogous to biological death. It is difficult to avoid the feeling that this is something which could happen in not so distant future. If this process corresponds to quantum jump, NMP tells that negentropy is generated but does not exclude the possibility of a catastrophe in which even entire species suffers extinction and some of our relatives, maybe bonobos, take the lead. The transition could also lead to a new higher level of consciousness with the prevailing materialistic world view being replaced with a new one? The individuals who have become aware about the need for a new world view and about what it might be could serve as seeds of the quantum phase transition.

7.3.5 ZPE or ZEO?

Laws of physics and conservation laws are the basic problem of Haisch and all those who want free will in the existing ontology of physics. Haisch is also a physicist so that the problem becomes

even more difficult to circumvent! How God can re-create the reality without breaking the well-established conservation laws? Or are these laws just rules of game that God has chosen to obey in this particular part of multiverse? But would this lead to mere quantum randomness and does statistical determinism mean a loss of genuine free will?

If I have guessed correctly, Haisch hopes that ZPE could help God over this problem but to my opinion ZPE is mathematically hopelessly ill-defined and reflects the mathematical problems of quantum field theory rather than reality.

In TGD framework ZPE is effectively replaced with ZEO - zero energy ontology instead of zero point energy. Zero energy states have vanishing total quantum numbers so that re-creation can be carried out without breaking conservation laws and standard laws of physics remain true. One can assign to the positive (say) energy part of zero energy state conserved energy and other quantum numbers and positive and negative energy parts correspond to initial and final state of physical event in the usual positive energy ontology: no states - just events! Therefore there is room also for God in TGD Universe. Together with re-creation as quantum jump one obtains maximal free will: any zero energy state can be created or vacuum in principle.

A possible test for ZEO would be creation of zero energy states apparently breaking conservation laws in the framework of positive energy ontology. In cosmology the non-conservation of gravitational energy indeed takes place and can be understood in terms of ZEO: the energy and other quantum numbers are conserved only in scale which correspond to spotlight of consciousness defined by one particular causal diamond (CD). Therefore also the consistency of Poincare invariance of TGD with cosmology requires ZEO.

Does the replacement of personal CD with a larger one in quantum jump (perhaps increasing the effective value of Planck constant) involve also generation of smaller sub-CDs representing mental images. Are our mental images these tiny Universes that we create?

How to a new sub-Universe this in laboratory? Quantum physicists would perhaps speak about generating long lived enough quantum fluctuations creating matter from vacuum. I remember having seen a popular article about a planned experiment in which very intense laser beams would generate particle pairs from vacuum. Of course, the probability for generating CD containing matter might be very small but maybe for some selected CDs this might not be the case!

7.3.6 The origin of inertia

Haisch and Rueda claim of having derived inertia appearing as a mass parameter in Newton's equations from vacuum energy (see <http://tinyurl.com/yafx6aew>). The basic idea behind the derivation does not however make much sense to me. Here is the condensed form of argument.

If one assumes that the quarks and electrons in such an object scatter this radiation, the semi-classical techniques of stochastic electrodynamics show that there will result a reaction force on that accelerating object having the form $f_r = \mu a$, where the μ parameter quantifies the strength of the scattering process. In order to maintain the state of acceleration, a motive force f must continuously be applied to balance this reaction force f_r . Applying Newton's third law to the region of contact between the agent and the object, $f = f_r$, we thus immediately arrive at $f = \mu a$, which is identical to Newton's equation of motion.

I confess that I have do not have a slightest idea what this statement might mean. The standard wisdom is that particle to which no forces are applied does not suffer acceleration. Now it would suffer acceleration although net force vanishes: $f + f_r = 0$.

The standard view is that in special relativity Poincare invariance combined with Noether's theorem allows to assign to any system conserved four-momentum and angular momentum. Given a variational principle coupling particles to fields one obtains automatically the analog of Newton's equations stating that the momentum lost/gained by fields is gained/lost by particles. Therefore in special relativity based theories there are no problems.

In general relativity situation however changes.

1. First of all, space-time becomes curved and the symmetries behind Poincare invariance are lost. One cannot use Noether's theorem to deduce expressions for conserved quantities: this is especially catastrophic outcome in quantum theory where the conserved quantities interpreted as operators play fundamental role. This was indeed the basic motivation of TGD: by replacing abstract space-time with a 4-D surface in higher-D space possessing the symmetries of empty Minkowski space, one does not lose the classical conservation laws.

2. There is also another, closely related problem. In Newtonian approach to gravity gravitation accelerating test particle experiences a genuine force. In general relativity test particle however suffers no acceleration nor force. There seems to be now manner for how these pictures could be consistent. Maybe Haisch and Rueda were thinking about this aspect when they made their attempt to derive inertia from vacuum energy in general relativistic context.

TGD provides a neat solution also to this problem. At 4-D space-time level the orbit of neutral test particle is indeed a geodesic line and 4-D acceleration vanishes. At 8-D embedding space level the orbit of test particle is not a geodesic line anymore and it experiences genuine 8-D acceleration, whose M^4 part defines the Newtonian force. The CP_2 part of the force is also present can be neglected since the scale of CP_2 is so small (about 10^4 Planck lengths).

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