

# Time and Consciousness

M. Pitkänen<sup>1</sup>, February 1, 2006

<sup>1</sup> Department of Physical Sciences, High Energy Physics Division,  
PL 64, FIN-00014, University of Helsinki, Finland.  
matpitka@rock.helsinki.fi, <http://www.physics.helsinki.fi/~matpitka/>.

Recent address: Puutarhurinkatu 10,10960, Hanko, Finland.

## Contents

<b>1</b>	<b>Introduction</b>	<b>5</b>
1.1	The concepts of self and subjective memory . . . . .	7
1.2	Psychological time and its arrow . . . . .	7
1.3	Cosmology of consciousness . . . . .	8
1.4	Four-dimensional brain . . . . .	8
1.5	Good and Evil, Life and Death . . . . .	9
1.6	Evidence for TGD based time concept . . . . .	9
<b>2</b>	<b>TGD based concept of time</b>	<b>10</b>
2.1	'Holy trinity' of time developments . . . . .	10
2.1.1	The general structure of quantum jump . . . . .	11
2.1.2	Localization in zero modes is necessary . . . . .	12
2.2	Quantum jump as moment of consciousness and the notion of self	14
2.3	Some aspects of classical non-determinism . . . . .	15
2.3.1	Vacuum extremals . . . . .	15
2.3.2	Mind like space-time sheets as deformations of vacuum extremals . . . . .	16
2.3.3	Are unions of absolute minima and vacuum extremals ab- solute minima? . . . . .	17
2.3.4	Massless extremals as quantum gravitational holograms .	17
2.4	Two times . . . . .	18
2.5	About the arrow of psychological time . . . . .	19
2.5.1	Two earlier views about how the arrow of psychological time emerges . . . . .	19
2.5.2	The third option . . . . .	19
2.6	Questions related to the notion of self . . . . .	21
2.6.1	Can one choose between the two variants for the notion of self or are they equivalent? . . . . .	21
2.6.2	Does entanglement mean loss of consciousness? . . . . .	25
2.6.3	What after biological death? . . . . .	26
2.7	Memory and time . . . . .	26

2.7.1	Do declarative memories and intentional action involve communications with geometric past? . . . . .	26
2.7.2	Episodal memories as time-like entanglement . . . . .	27
2.8	Cosmology of consciousness . . . . .	27
2.9	Communications in four-dimensional society . . . . .	29
2.9.1	Communication method . . . . .	29
2.9.2	Anomalies related to spinning astrophysical objects as empirical support for the idea . . . . .	30
<b>3</b>	<b>Four-dimensional brain</b>	<b>31</b>
3.1	The paradigm of four-dimensional brain . . . . .	32
3.2	Geometric and subjective memories . . . . .	33
3.3	Memories with respect to geometric time as simulations . . . . .	33
3.4	Are long term memories geometric or subjective memories? . . . . .	34
3.4.1	Long term memories as geometric memories? . . . . .	35
3.4.2	Long term memories as subjective memories of higher level self? . . . . .	36
3.4.3	Long term memories as a communication between now and geometric past . . . . .	37
3.5	Quantum physical model for Boolean mind and cognition . . . . .	38
3.5.1	Zero energy neutrino pairs . . . . .	42
3.5.2	General model for Boolean mind based on zero energy neutrino pairs . . . . .	44
3.5.3	Zero energy fermion pairs associated with time loops . . . . .	46
3.5.4	Is there empirical evidence for negative energy fermions? . . . . .	49
<b>4</b>	<b>Good and Evil, Life and Death</b>	<b>50</b>
4.1	Quantum ethics very briefly . . . . .	51
4.2	Ageing and death . . . . .	52
4.3	Death as disappearance of the mental image representing the physical body? . . . . .	53
4.4	How the law of Karma could be realized? . . . . .	54
4.5	What 'liberation' might mean? . . . . .	55
4.5.1	Liberation experience as "cosmic consciousness" . . . . .	56
4.5.2	'Liberated souls' as $S \leq 0$ selves . . . . .	57
4.5.3	'Liberated souls' geometrically . . . . .	58
4.5.4	How to observe 'liberated souls'? . . . . .	59
4.5.5	Do liberated souls leave black holes behind them? . . . . .	60
4.6	What after the physical death?: the vision provided by a more precise view about psychological time . . . . .	61
4.6.1	Is the subjective lifetime of 4-D body finite? . . . . .	63
4.6.2	Saints and sinners, heaven and hell . . . . .	65
4.6.3	Are reincarnations in the geometric future possible? . . . . .	66
4.6.4	Are reincarnations in geometric past possible? . . . . .	66

<b>5</b>	<b>Time delays of consciousness and quantum jumps between histories</b>	<b>68</b>
5.1	Dissipation as evidence for consciousness . . . . .	68
5.2	Experiments related to the active role of consciousness . . . . .	69
5.3	Experiments related to the passive role of consciousness . . . . .	70
5.4	The experiment of Radin and Bierman as evidence for quantum jump between quantum histories concept . . . . .	74

### Abstract

In moments of consciousness as quantum jumps between quantum histories picture 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 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 imbedding space. These identifications did not lead to anything practical and generated paradoxes.

The most recent proposal involves no ad hoc assumptions and relies on the recent formulation of quantum TGD using zero energy ontology. The correlate of self is now so called causal diamond (pair of future and past directed light-cones) which is 8-D sub-manifold of the imbedding space rather than space-time sheet. The flow of geometric time is apparent and due the change of quantum state in quantum jump which in the first approximation means a shift of the quantum superposition of space-time surfaces to the direction of the geometric past of the imbedding space. This proposal allows to understand the asymmetry between geometric future and past at the level of conscious experience and makes also precise quantitative predictions. Also a unification of the definition of self identifying it as a sequence of quantum jumps and of the definition based on the reduction of self hierarchy to a fractal hierarchy of quantum jumps within quantum jumps becomes possible.

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.

"Ontogeny recapitulates phylogeny" principle suggests that the structure of the many-sheeted space-time represents the structure of the cosmology of consciousness. This heuristic principle together with the concept of self, the hypothesis that also infinite primes are present in the topological condensate and association sequence concept, leads to a Grand Scenario for the cosmology of consciousness. There is no need to assume that different irreducible sub-experiences associated with given moment of consciousness correspond to a common value of the psychological time.

Most naturally, the values of psychological time extending from zero to strictly infinite values of time and beyond(!) are present. This means that cosmology of consciousness has fractal like structure: there are sub-cosmologies which know nothing about each other's existence except in quantum jumps involving entanglement with larger space-time sheets: in this case the conscious experience could be regarded as a religious or mystic experience. Both future and past civilizations participate in each quantum jump. The allowance of infinite primes suggested strongly by various arguments, means that conscious intelligences which are God like as compared to us, participate in each quantum jump.

An especially important general consequence is the paradigm of 4-dimensional brain.

a) This paradigm trivializes the problem of long term memory. The desire to remember would be quantum communicated from the geometric now to the geometric past by sharing of mental images made possible by time-like quantum entanglement of sub-selves. In the case of episodal memories the sharing of mental images gives already rise to the memory. For non-episodal memories the memory is communicated classically to the geometric future. An essential element of the mechanism are negative energy MEs ("massless extremals") which are ideal for generating time-like quantum entanglement with the geometric past. Positive energy MEs are in turn involved with classical communications.

b) Second consequence is a model of cognition relying on the concept of cognitive neutrino pair: cognitive neutrino pair has almost vanishing total energy and consists of neutrino and antineutrino residing at different space-time sheets. The cornerstone of the model is the negative energy of the condensed matter neutrinos deriving from the classical  $Z^0$  interaction with nuclear  $Z^0$  charges. Thus one can say that TGD predicts that  $k = 169$  space-time sheet ( $L(169) \simeq 5$  microns) is the length scale in which cognitive consciousness emerges.

Quantum jumps between quantum histories concept explains the peculiar time delays of consciousness revealed in the experiments relating to active and passive roles of consciousness and the causal anomalies revealed by the experiments of Radin and Bierman. TGD predicts "tribar effect" as a general signature for the quantum jump between quantum histories concept.

## 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 manner 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 imbedding 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.

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 and subjective memory

Self is identified as a subsystem able to remain unentangled during informational "time evolutions"  $U$  associated with subsequent quantum jumps. Or putting it differently: self is a subsystem behaving like its own sub-Universe (with respect to NMP). 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 phonenumber.

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 Psychological time and its arrow

Quantum classical correspondence requires that the flow of subjective time identified as a sequence of quantum jumps should have the flow of geometric time as a space-time correlate. The understanding of the detailed relationship between these two times has however remained a long standing problem, and I have proposed several models involving ad hoc assumptions. Only the emergence of zero energy ontology allows an ad hoc free model for how the experienced flow and arrow of geometric time emerge, and answers why the relationship between geometric past and future is so asymmetric and why sensory experience is about so narrow interval of geometric time. Also the notion of self reduces in well-defined sense to the notion of quantum jump with fractal structure.

The basic idea about the correspondence between subjective and geometric time is very simple. Configuration space spinor field represents a quantum superposition of space-time surfaces. Assume that the attention of self is directed to a fixed volume of the 8-D imbedding space. Quantum classical correspondence requires that this quantum superposition in the first approximation shifts towards geometric past of the imbedding space so that self experiences effective flow of the geometric time associated with the space-time surface. This explanation works only if macroscopic quantum coherence holds true so that one cannot regard the space-time surface as a fixed arena of dynamics. Also the

representability of the space-time surfaces as sub-manifolds of 8-D imbedding space is essential. The identification of the fundamental volume of attention as a causal diamond inspired by zero energy ontology based formulation of quantum TGD provides answers to more detailed questions. This identification means also that causal diamond of imbedding space rather than space-time sheet becomes the space-time correlate of self.

### 1.3 Cosmology of consciousness

The cosmology of consciousness is inspired by the prediction of the infinite self hierarchy and by quantum-classical correspondence principle [H2]. 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 p-adic topology which the real region is near criticality to transform to. Just like configuration space has 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.

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 representing systems participating in every moment of consciousness, means also dramatically new manner 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.

### **1.5 Good and Evil, Life and Death**

Classical-quantum correspondence principle (and also "Ontogeny recapitulates phylogeny" principle in very general form) suggests that the subjective evolution of an organism could be an endless process just like the p-adic evolution of the entire universe is. This inspires the question about what might happen in the physical death. One could also wonder whether the Buddhist ideas about law of Karma, reincarnation and liberation could have physical correlates. The notions of self and mind like space-time sheet; the view about life as a symbiosis of fractal hierarchies of massless extremals (MEs) and magnetic flux tube structures with the ordinary matter, and quantum-classical correspondence principle make it possible to consider possible answers to these questions. Of course, everything to be said is just speculation and should be taken as necessary exercises needed to learn to work with new concepts and ideas.

### **1.6 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 [19, 22] and the causal anomalies revealed by the experiments of Radin and Bierman [32, 33, 34]. 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.

## 2 TGD based concept of time

TGD based notion of time involves several new aspects. 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 classical non-determinism of Kähler action is second 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. 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. A further new element is related to the possibility of negative energy space-time sheets and classical communications also to the direction of geometric past. The final important ingredient is p-adic physics as physics of cognition and intention having rather exotic implications, such as replication of p-adic memes by time reflection, their instantaneous propagation by the same mechanism, and time reversed cognition. p-Adic physics as physics of intentionality is crucial for understanding of the psychological time as a front of p-adic-to-real phase transition transforming intentions to actions [H8].

### 2.1 'Holy trinity' of time developments

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

### 2.1.1 The general structure of quantum jump

It has gradually become clear that TGD involves "holy trinity" of dynamics.

1. The dynamics defined by the absolute minimization of the Kähler action corresponds to the dynamics of material existence, with matter defined as "res extensa", three-surfaces.
2. The dynamics defined by the action of the unitary 'time development' operator  $U$  in the space of quantum histories, is the counterpart of the ordinary Schrödinger time evolution  $U \equiv U(-t, t \rightarrow \infty)$  and can be regarded as "informational" time development occurring at the level of objective existence. It seems however un-necessary and in fact impossible to assign real Schrödinger time evolution with  $U$ .  $U$  defines the S-matrix of the theory.
3. The dynamics of quantum jumps between quantum histories corresponds to the dynamics of subjective existence.

Quantum jump was originally seen as something totally irreducible. Gradually the structure of quantum jump has revealed itself.

1. The first step in quantum jump is 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 universe being in a holistic state of 'oneness'.

2. Then follows the TGD counterpart of state function reduction realized as a localization in zero modes:

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

The assumption that localization occurs in zero modes of the configuration space poses very important consistency condition on  $U$ : it must effectively correspond to a flow in zero modes such that 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 together with the fact that zero modes are effectively classical variables, implies that the localization in zero modes corresponds to a state function reduction. All p-adic configuration space degrees of freedom are zero modes so that in this sense cognition is classical. Only so called quaternion conformal fermionic p-adic degrees of freedom are quantal.

3. The state function reduction is followed by a cascade of self measurements in quantum fluctuating degrees of freedom (zero modes do not change during this stage)

$$\Psi_f^0 \rightarrow \dots \rightarrow \Psi_f \text{ ,}$$

whose dynamics is governed by the Negentropy Maximization Principle (NMP). This process leads to a completely unentangled state (apart from entanglement present in bound states) identifiable as a prepared state. This process can be regarded as an analysis or even decay process.

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 quantum computation lasting infinitely long time  $t \rightarrow \infty$  followed by a state preparation of the initial state of the next quantum computation.

### 2.1.2 Localization in zero modes is necessary

The detailed inspection of what happens in quantum jumps leads to a surprising conclusion that quantum jump involves always complete localization in zero modes. The argument leading to this conclusion goes as follows.

1. QFT picture strongly suggests that sub-system must be defined as a tensor factor of the space of configuration space spinors at given point  $Y^3$  of the configuration space. 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. Configuration space 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 configuration space 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, configuration space 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 configuration space spinor field to some  $Y^3$  plus further quantum jump reducing entanglement in  $Y^3$ . Complete localization in the configuration space 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 Canonical algebras, is not consistent with this requirement.

3. Under rather reasonable assumptions one can however replace complete localization with a localization in the zero modes. Configuration space has fiber space structure. Configuration space 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. Configuration space 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 hence depend on the zero modes only*. If this is really the case then the localization in zero modes leads to a state for which entanglement coefficients and density matrix do not depend on the fiber degrees of freedom.
4. 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 configuration space 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 configuration space 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.
5. 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 configuration space 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 configuration space coordinates of 3-surfaces as additional index. The analogy with the spin glass also supports the localization in the zero modes.

6. 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.

## 2.2 Quantum jump as moment of consciousness and the notion of self

If quantum jump occurs between two different time evolutions of Schrödinger equation (understood here in very metaphorical sense) rather than interfering with single deterministic Schrödinger evolution, the basic problem of quantum measurement theory finds a resolution. The interpretation of quantum jump as a moment of consciousness means that volition and conscious experience are outside space-time and state space and that quantum states and space-time surfaces are "zombies". Quantum jump would have actually a complex anatomy corresponding to unitary process  $U$ , state function reduction and state preparation at least.

Quantum jump has a complex anatomy since it must include state preparation, state function reduction, and also unitary process characterized by  $U$ -matrix. Zero energy ontology means that one must distinguish between  $M$ -matrix and  $U$ -matrix.  $M$ -matrix characterizes the time like entanglement between positive and negative energy parts of zero energy state and is measured in particle scattering experiments.  $M$ -matrix need not be unitary and can be identified as a "complex" square root of density matrix representable as a product of its real and positive square root and of unitary  $S$ -matrix so that thermodynamics becomes part of quantum theory with thermodynamical ensemble being replaced with a zero energy state. The unitary  $U$ -matrix describes quantum transitions between zero energy states and is therefore something genuinely new. It is natural to assign the statistical description of intentional action with  $U$ -matrix.

Intuitively self corresponds to a sequence of quantum jumps which somehow integrates to a larger unit much like many-particle bound state is formed from more elementary building blocks. It also seems natural to assume that self stays conscious as long as it can avoid bound state entanglement with the environment: everything is conscious and consciousness can be only lost. This view predicts infinite self hierarchy with the entire Universe at the top.

If one accepts the hierarchy of Planck constants [C10], it might be unnecessary to distinguish between self and quantum jump. The hierarchy of

Planck constants interpreted in terms of dark matter hierarchy predicts a hierarchy of quantum jumps such that the size of space-time region contributing to the contents of conscious experience scales like  $\hbar$ . Also the hierarchy of space-time sheets labeled by p-adic primes suggests the same. That sequence of sub-selves/sub-quantum jumps are experienced as separate mental images explains why we can distinguish between digits of phone number. The irreducible component of self (pure awareness) would correspond to the highest level in the "personal" hierarchy of quantum jumps and the sequence of lower level quantum jumps would be responsible for the experience of time flow. Entire life cycle would correspond to single quantum jump at the highest(?) level of the personal self hierarchy and pure awareness would prevail during sleep: this would make it possible to experience directly that I existed yesterday. Whether these two definitions of self are in some sense equivalent will be discussed later.

Self is assumed to experience sub-selves as mental images identifiable as "averages" of their mental images. This implies the notion of ageing of mental images as being due to the growth of ensemble entropy as the ensemble consisting of quantum jumps (sub-sub-selves) increases.

There are thus two definitions of self. The first definition introduces self as a notion separate from quantum jump. Second definition reduces the notion of self to a fractal hierarchy of quantum jumps. The equivalence between two definitions of the notion of self will be proposed later.

## 2.3 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.

### 2.3.1 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 extremals are vacuum extremals having 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.

The absolute minimization of the Kähler action forces to deform the vacuum extremals to non-vacuum extremals. 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 although it seems that p-adic-to-real phase transitions are responsible for the transformation of intentions to actions. It seems that the  $CP_2$  type extremals representing cognitive neutrino pairs are crucial for our cognitive consciousness and its transformation to symbolic representations.

### 2.3.2 Mind like space-time sheets as deformations of vacuum extremals

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 absolute minimum with 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 matter like space-time sheets, they provide sensory and symbolic representations for some aspects of the material world. Hence they are excellent candidates for the geometric counterparts of selves. For instance, the time evolution of our body could 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.

Note that the surfaces obtained by gluing vacuum extremals do not anymore correspond to  $Y^3$  at light cone boundary but to association sequences containing besides  $Y^3$  also 3-surfaces not belonging to the light cone boundary. Generalized causality makes it possible to avoid paradoxical situation: assuming that space-time surface  $X^4(Y^3)$  is absolute minimum 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  $X^4(Y^3)$ . Note that it is not at all clear whether one can find absolute minimum surface  $X^4(Y^3)$  for  $Y^3$  containing only component on light cone boundary: due to the presence of the vacuum extremals  $Y^3$  might be always accompanied by a set of 3-surfaces not belonging to the light cone boundary.

### 2.3.3 Are unions of absolute minima and vacuum extremals absolute minima?

There is a peculiar problem, perhaps even paradox, related to the vacuum extremals. It is not obvious whether the unions of absolute minima and vacuum extremals are also absolute minima for some 3-surface? Typically non-determinism could correspond to space-time sheets of a finite duration glued to  $X^4(Y^3)$  already found. Indeed, if  $X^4(Y^3)$  is absolute minimum, one can form a disjoint union of any vacuum extremal and  $X^4(Y^3)$  getting space-time surface with the same value of Kähler action. The generic vacuum extremal [D1] intersects  $X^4(Y^3)$  in a discrete point set but by cutting small spheres from vacuum extremals around intersection points one gets a disjoint union of modified vacuum extremal and  $X^4(X^3)$  which is new degenerate absolute minimum. For these vacua the non-determinism is not describable as a discrete sequence of multi-furcations: the only manner is to give entire vacuum extremal to characterize the entire surface.

Something like a continuous version of association sequence seems to be in question and it is not clear whether one should allow not only association sequences but unions of  $Y^3$  belonging to the light cone boundary with vacuum space-time surfaces! The addition of these vacua does not provide cognitive representations for the non-vacuum space-time surface except in purely topological sense as holes created on vacuum extremal at the intersection points. The sensory content of this kind of vacuum would be more akin to a hallucination or completely free imagination or perhaps a state of enlightenment with liberation from the determinism of the material world!

Perhaps the simplest manner to get rid of the paradox is to require that all vacuum absolute minima are such that enumerable number of 3-surfaces with time like separations specifies the absolute minimum completely. In this kind of situation deformation to locally non-vacuum extremal having vanishing total classical conserved quantities would occur. It however seems that these absolute minima could be arbitrarily near to vacuum extremals since the temporal interval between two 3-surfaces in association sequence can be arbitrarily small.

Especially interesting are closed vacuum absolute minima of finite temporal duration and possessing no boundaries. These absolute minima could quite well have Euclidian induced metric and non-vanishing action which is automatically negative. These absolute minima can be also non-vacuum extremals locally although the sum of the energies associated with various space-time sheets must vanish. The solutions of Dirac equation for the induced spinors have also vanishing total energy for these extremals.

### 2.3.4 Massless extremals as quantum gravitational holograms

Massless extremals (MEs) have turned out to be perhaps the most fundamental solutions of field equations as far TGD inspired theory of consciousness is considered. 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 configuration space 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  $\delta M_+^4$  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  $\delta M_+^4$  is replaced by a fractal structure formed by  $\delta M_+^4$  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.

There are good reasons to expect that the light like selves defined by the boundaries of MEs are fundamental in TGD inspired theory of consciousness. The super-canonical quantum states associated with these boundaries are genuine quantum gravitational states defined by configuration space functionals, whose dependence on the bosonic fiber degrees of freedom of the configuration space 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, 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.

## 2.4 Two times

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.

## 2.5 About the arrow of psychological time

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 is problematic.

### 2.5.1 Two earlier views about how the arrow of psychological time emerges

The basic question how the arrow of subjective time is mapped to that of geometric time. The common assumption of all models is that quantum jump sequence corresponds to evolution and that by quantum classical correspondence this evolution must have a correlate at space-time level so that each quantum jump replaces typical space-time surface with a more evolved one.

1. 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.
  - i) Why this drifting?
  - ii) 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).
  - iii) 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 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.

There are also other models but these two are the ones which represent basic types for them.

### 2.5.2 The third option

The third explanation for the arrow of psychological time - which I have considered earlier but only half-seriously - looks to me the most elegant at this moment. This option is actually favored by Occam's razor since it uses only the

assumption that space-time sheets are replaced by more evolved ones in each quantum jump. Also the model of tqc favors it.

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 imbedding 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 imbedding 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? Zero energy ontology allows to give tentative answers to these questions.

## 2.6 Questions related to the notion of self

I have proposed two alternative notions of self and have not been able to choose between them. A further question is what happens during sleep: do we lose consciousness or is it that we cannot remember anything about this period? The work with the model of topological quantum computation has led to an overall view allowing to select the most plausible answer to these questions. But let us be cautious!

### 2.6.1 Can one choose between the two variants for the notion of self or are they equivalent?

I have considered two different notions of "self" and it is interesting to see whether the new view about time might allow to choose between them or to show that they are actually equivalent.

1. In the original variant of the theory "self" corresponds to a sequence of quantum jumps. "Self" would result through a binding of quantum jumps to single "string" in close analogy and actually in a concrete correspondence with the formation of bound states. Each quantum jump has a fractal structure: unitary process is followed by a sequence of state function reductions and preparations proceeding from long to short scales. Selves can have sub-selves and one has self hierarchy. The questionable assumption is that self remains conscious only as long as it is able to avoid entanglement with environment.

Even slightest entanglement would destroy self unless one introduces the notion of finite measurement resolution applying also to entanglement. This notion is indeed central for entire quantum TGD also leads to the notion of sharing of mental images: selves unentangled in the given measurement resolution can experience shared mental images resulting as fusion of sub-selves by entanglement not visible in the resolution used.

2. According to the newer variant of theory, quantum jump has a fractal structure so that there are quantum jumps within quantum jumps: this hierarchy of quantum jumps within quantum jumps would correspond to the hierarchy of dark matters labeled by the values of Planck constant. Each fractal structure of this kind would have highest level (largest Planck constant) and this level would correspond to the self. What might be called irreducible self would correspond to a quantum jump without any sub-quantum jumps (no mental images). The quantum jump sequence for lower levels of dark matter hierarchy would create the experience of flow of subjective time.

It would be nice to reduce the original notion of self hierarchy to the hierarchy defined by quantum jumps. There are some objections against this idea. One can argue that fractality is a purely geometric notion and since subjective experience does not reduce to the geometry it might be that the notion of fractal quantum jump does not make sense. It is also not quite clear whether the reasonable looking idea about the role of entanglement as destroyer of self can be kept in the fractal picture.

These objections fail if one can construct a well-defined mathematical scheme allowing to understand what fractality of quantum jump at the level of space-time correlates means and showing that the two views about self are equivalent. The following argument represents such a proposal. Let us start from the causal diamond model as a lowest approximation for a model of zero energy states and for the space-time region defining the contents of sensory experience.

Let us make the following assumptions.

1. Assume the hierarchy of causal diamonds within causal diamonds in a sense to be specified more precisely below. Causal diamonds would represent the volumes of attention. Assume that the highest level in this hierarchy defines the quantum jump containing sequences of lower level quantum jumps in some sense to be specified. Assume that these quantum jumps integrate to single continuous stream of consciousness as long as the sub...-sub-self in question remains unentangled and that entangling means loss of consciousness or at least that it is not possible to remember anything about contents of consciousness during entangled state.
2. Assume that the contents of conscious experience come from the interior of the causal diamond. A stronger condition would be that the contents come from the boundaries of the two light-cones involved since physical states are defined at these in the simplest picture. In this case one could identify the lower light-cone boundary as giving rise to memory.
3. The time span characterizing the contents of conscious experience associated with a given quantum jump would correspond to the temporal distance  $T$  between the tips of the causal diamond.  $T$  would also characterize the average and approximate shift of the superposition of space-time surfaces backwards in geometric time in single quantum jump at a given

level of hierarchy. This time scale naturally scales as  $T_n = 2^n T_{CP_2}$  so that p-adic length scale hypothesis follows as a consequence.  $T$  would be essentially the secondary p-adic time scale  $T_{2,p} = \sqrt{p} T_p$  for  $p \simeq 2^k$ . This assumption - absolutely essential for the hierarchy of quantum jumps within quantum jumps - would differentiate the model from the model in which  $T$  corresponds to either  $CP_2$  time scale or p-adic time scale  $T_p$ . One would have hierarchy of quantum jumps with increasingly longer time span for memory and with increasing duration of geometric chronon at the highest level of fractal quantum jump. Without additional restrictions, the quantum jump at  $n^{th}$  level would contain  $2^n$  quantum jumps at the lowest level of hierarchy. Note that in the case of sub-self - and without further assumptions which will be discussed next - one would have just two quantum jumps: mental image appears, disappears or exists all the time. At the level of sub-sub-selves 4 quantum jumps and so on. Maybe this kind of simple predictions might be testable.

4. We know that that the contents of sensory experience comes from a rather narrow time interval of duration about .1 seconds, which corresponds to the time scale  $T_{127}$  associated with electron. We also know that there is asymmetry between positive and negative energy parts of zero energy states both physically and at the level of conscious experience. This asymmetry must have some space-time correlate. The simplest correlate for the asymmetry between positive and negative energy states would be that the upper light-like boundaries in the structure formed by light-cones within light-cones intersect along light-like radial geodesic. No condition of this kind would be posed on lower light-cone boundaries. The scaling invariance of this condition makes it attractive mathematically and would mean that arbitrarily long time scales  $T_n$  can be present in the fractal hierarchy of light cones. At all levels of the hierarchy all contribution from upper boundary of the causal diamond to the conscious experience would come from boundary of same past directed light-cone so that the conscious experience would be sharply localized in time in the manner as we know it to be. The new element would be that content of conscious experience would come from arbitrarily large region of Universe and seeing Milky Way would mean direct sensory contact with it.
5. These assumptions relate the hierarchy of quantum jumps to p-adic hierarchy. One can also include also dark matter hierarchy into the picture. For dark matter hierarchy the time scale hierarchy  $\{T_n\}$  is scaled by the factor  $r = \hbar/\hbar_0$  which can be also rational number. For  $r = 2^k$  the hierarchy of causal diamonds generalizes without difficulty and there is a kind of resonance involved which might relate to the fact that the model of EEG favors the values of  $k = 11n$ , where  $k = 11$  also corresponds in good approximation to proton-electron mass ratio. For more general values of  $\hbar/\hbar_0$  the generalization is possible assuming that the position of the upper tip of causal diamond is chosen in such a manner that their positions are always the same whereas the position of the lower light-cone boundary

would correspond to  $\{rT_n\}$  for given value of Planck constant. Geometrically this picture generalizes the original idea about fractal hierarchy of quantum jumps so that it contains both p-adic hierarchy and hierarchy of Planck constants.

The contributions from lower the boundaries identifiable in terms of memories would correspond to different time scales and for a given value of time scale  $T$  the net contribution to conscious experience would be much weaker than the sensory input in general. The asymmetry between geometric now and geometric past would be present for all contributions to conscious experience, not only sensory ones. What is nice that the contents of conscious experience would rather literally come from the boundary of the past directed light-cone along which the classical signals arrive. Hence the mystic feeling about telepathic connection with a distant object at distance of billions of light years expressed by an astrophysicist, whose name I have unfortunately forgotten, would not be romantic self deception.

This framework explains also the sharp distinction between geometric future and past (not surprisingly since energy and time are dual): this distinction has also been a long standing problem of TGD inspired theory of consciousness. Precognition is not possible unless one assumes that communications and sharing of mental images between selves inside disjoint causal diamonds is possible. Physically there seems to be no good reason to exclude the interaction between zero energy states associated with disjoint causal diamonds.

The mathematical formulation of this intuition is however a non-trivial challenge and can be used to articulate more precisely the views about what configuration space and configurations space spinor fields actually are mathematically.

1. Suppose that the causal diamonds with tips at different points of  $H = M^4 \times CP_2$  and characterized by distance between tips  $T$  define sectors  $CH_i$  of the full configuration space  $CH$  ("world of classical worlds"). Precognition would represent an interaction between zero energy states associated with different sectors  $CH_i$  in this scheme and tensor factor description is required.
2. Inside given sector  $CH_i$  it is not possible to speak about second quantization since every quantum state correspond to a single mode of a classical spinor field defined in that sector.
3. The question is thus whether the Clifford algebras and zero energy states associated with different sectors  $CH_i$  combine to form a tensor product so that these zero energy states can interact. Tensor product is required by the vision about zero energy insertions assignable to  $CH_i$  which correspond to causal diamonds inside causal diamonds. Also the assumption that zero energy states form an ensemble in 4-D sense - crucial for the deduction of scattering rates from  $M$ -matrix - requires tensor product.
4. The argument unifying the two definitions of self requires that the tensor product is restricted when  $CH_i$  correspond to causal diamonds inside each

other. The tensor factors in shorter time scales are restricted to the causal diamonds hanging from a light-like radial ray at the upper end of the common past directed light-cone. If the causal diamonds are disjoint there is no obvious restriction to be posed, and this would mean the possibility of also precognition and sharing of mental images.

This scenario allows also to answers the questions related to a more precise definition of volume of attention. Causal diamond - or rather - the associated light-like boundaries containing positive and negative energy states define the primitive volume of attention. The obvious question whether the attention of a given self is doomed to be fixed to a fixed volume can be also answered. This is not the case. Selves can delocalize in the sense that there is a wave function associated with the position of the causal diamond and quantum jumps changing this position are possible. Also many-particle states assignable to a union of several causal diamonds are possible. Note that the identification of magnetic flux tubes as space-time correlates of directed attention in TGD inspired quantum biology makes sense if these flux tubes connect different causal diamonds. The directedness of attention in this sense should be also understood: it could be induced from the ordering of p-adic primes and Planck constant: directed attention would be always from longer to shorter scale.

### **2.6.2 Does entanglement mean loss of consciousness?**

The ability to avoid entanglement with environment would be essential for the original notion of self and in case of sub-selves it would explain the finite life-time of mental images. One can of however ask whether the assumption about the loss of consciousness in entanglement - that is during sleep - is really necessary. One could however argue that if consciousness is really lost during sleep, we could not have the deep conviction that we existed yesterday. Furthermore, during topological quantum computation entanglement is absent and thus this state should correspond to conscious experience. Night time is however the best time for tqc since sensory input and motor action do not take metabolic resources and we certainly do problem solving during sleep. Thus we should be conscious at some level during sleep and perform quite a long tqc. Perhaps we are!

Could it be that we do not remember anything about the period of sleep because our attention is directed elsewhere and memory recall uses only copies of "me" assignable to brain manufacturing standardized mental images? Perhaps the communication link to the mental images during sleep experienced at dark levels of existence is lacking or sensory input and motor activities of busy westerners do not allow to use metabolic energy to build up this kind of communications. Hence one can seriously ask, whether self is actually eternal with respect to the subjective time and whether entangling with some system means only diving into the ocean of consciousness as someone has expressed it. We would be Gods as also quantum classical correspondence in the reverse direction requires (p-adic cognitive space-time sheets have literally infinite size in both

temporal and spatial directions). This would be the most optimistic view that one can imagine.

### 2.6.3 What after biological death?

Could the new option allow to speculate about the course of events at the moment of death? Certainly this particular sensory "me" would effectively meet the geometro-temporal boundary of the biological body: sensory input would cease and there would be no biological body to use anymore. "Me" might lose its consciousness (if it can!). "Me" has also other mental images than sensory ones and these could begin to dominate the consciousness and "me" could direct its attention to space-time sheets corresponding to much longer time scale, perhaps even to that of life cycle, giving a summary about the life.

What after that? The Tibetan Book of Dead gives some inspiration. A western "me" might hope (and even try use its intentional powers to guarantee) that quantum Turing tape sooner later brings into the volume of attention (which might also change) a living organism, be it human or cat or dog or at least some little bug. If this "me" is lucky, it could direct its attention to it and become one of the very many sensory "me's" populating this particular 4-D biological body. There would be room for a newcomer unlike in the alternative models. A "me" with Eastern/New-Ageish traits could however direct its attention permanently to the dark space-time sheets and achieve what she might call enlightenment.

## 2.7 Memory and time

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

Communications with geometric past using time mirror mechanism 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 [H6].

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 [31].

Also a mechanism of remote metabolism ("quantum credit card") based on sending of negative energy signals to geometric past becomes possible [K6]: 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.

### 2.7.2 Episodal memories as time-like entanglement

Time-like entanglement explains episodal memories as sharing of mental images with the brain of geometric past [H6]. 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 [22] 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  $\sim 50$  years and corresponds to  $k = 7$  (amusingly, this corresponds to the highest level in chakra hierarchy).

## 2.8 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 configuration space 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 mind like and matter like space-time sheets, separate conscious cosmology. Mind like space-time sheets are bounded in time direction: the sheet of 3-space is born when a tiny energy flows into the sheet from some larger sheet and dies when this energy flows back to the larger background sheet. 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 dip 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.

One can represent an objection against this picture. p-Adic-to-real phase-transition front should be common to the entire biosphere at our level of self hierarchy at least. It is not clear in what time scale this is true and whether the geometric past can generate intentions which can effectively re-create the geometric past. If p-adic-to-real phase transition occurs in entire cosmology then one could say that there is universal psychological time. A concrete model for

p-adic cognition at neuronal level however suggests that there is no deep reason to assume that psychological time would be more than local. The paradoxes related to the transformation of intentions to actions in the geometric past are avoided if the effects of this nondeterminism are bounded to a time scale not longer than p-adic length scale. This would also conform with the hypothesis that the second law of thermodynamics holds true only in time scales longer than the p-adic length scale characterizing the space-time sheet in question.

## 2.9 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.

### 2.9.1 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 [I3, J4] "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" [J4] 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.

### **2.9.2 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 [35, 36] various anomalies related to spinning objects are reviewed. These anomalies are discussed in [G2]. There are also anomalies related to spinning astrophysical objects. Kozyrev [38] has conducted astronomical observations using a receiving system of a new type. These observations have been replicated later by other groups [39, 37]. 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 [D7]. 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 [20]. 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 [42] is developed in [G2]. 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.

### 3 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 non-determinism making possible intentionality and cognition.

### 3.1 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 absolute minima of Kähler action. 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.

### **3.2 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 wellknown 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.

### **3.3 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 sheet.

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 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.

### **3.4 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.

### 3.4.1 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.

### 3.4.2 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 join along boundaries bonds 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.

### 3.4.3 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 [H4], 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  $\Delta T$ . 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 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.

### 3.5 Quantum physical model for Boolean mind and cognition

TGD based theory of consciousness has reached such level of well-definedness that one can make serious attempts to construct physical models for Boolean mind and cognitive consciousness. The concepts of mind like space-time sheet, fermionic representation of Boolean algebra, and p-adic physics as physics of cognition are the three basic concepts involved. In this section the p-adic aspects are not considered much (the reason is very mundane: this chapter was written much before the connection between cognition and p-adics became clear!). To avoid confusions it is however worth of making clear in which sense the older picture makes sense in the new framework provided by p-adic physics as physics of cognition.

1. In p-adic context the inherent non-determinism of the p-adic field equations makes mind like sheets ideal as far as geometric correlates of imagination and cognition are considered. Real space-time sheets correspond to matter and symbolic representations. The non-determinism of the real Kähler action makes possible mind like space-time sheets of finite time duration identifiable as sensory and symbolic representations. The p-adic–real phase transitions occurring in quantum jumps and transforming p-adic space-time sheets to real ones and vice versa transform thoughts to actions or symbolic representations and vice versa. This picture provides the geometric counterpart of matter-mind dichotomy and of matter-mind interaction of Descartes.
2. The notion of a cognitive neutrino pair defined as a real zero energy neutrino pair developed before the realization of the p-adic view about cognition and gave rise to realization of Boolean statements as temporal sequences of real zero energy neutrino pairs. According to a more precise definition of cognition, neutrinos can be called cognitive only when p-adic. Both p-adic and real neutrino pairs are crucial and real zero energy neutrino pairs correspond to symbolic representations of thoughts inducing automatically nerve pulse patterns or membrane oscillations (the duration of nerve pulse is slightly longer than the duration of the bit of the memetic codon). In the following I try to follow this definition.
3. An attractive idea inspired by the general theory of qualia [K3] is that real zero energy neutrino pairs correspond to the Boolean counterpart of sensory experience. If so, p-adic-to-real transition would transform

a freely imagined, purely formal Boolean statement to an experienced truth of some kind. This brings in mind the the formal statements of abstract propositional logic without fixed truth values contra the models of the logic system assigning definite truth values to these statements. Our beliefs would correspond to p-adic Boolean statements transformable to real statements just like the repertoire of our motor actions would correspond to intentions transformable to actions.

One can distinguish between two kinds of fermionic degrees of freedom: those associated with the configuration space metric and those accompanying the called quaternion conformal degrees of freedom responsible for the ordinary elementary particles. In the p-adic context only the quaternion conformal fermionic degrees of freedom are present. A possible interpretation is in terms of 'Truth, Beauty, Goodness' trinity. There are three kinds of Boolean statements: logical true/false type statements (p-adic fermions and cognition), aesthetic beautiful/ugly type statements (fermions associated with the configuration space geometry and sensory experience), and ethical right/wrong type statements (real quaternion conformal fermions).

If this identification has some sense, zero energy neutrino pairs and their real counterparts would contribute to the logical and ethical Boolean mind. The fact that we make also aesthetic judgements would suggest that the fermionic degrees of freedom associated with the configuration space metric and representing genuinely new physics, are present. Of course, also the fact that we have sensory qualia requires that configuration space metric degrees of freedom are present. What is special is that these degrees of freedom do not carry four-momentum but only color and angular momentum-like quantum numbers so that they are not easily detectable by ordinary physical measurements. Note that this makes it easy to generate these fermions from vacuum.

The transformation to real zero energy pairs could be also involved with the symbolic expression of cognition, presumably underlying speech (recall that the members of primitive societies are not able to say that they mother is dead unless this is really the case). More precisely, real zero energy neutrino pairs could correspond to symbolic expression of cognition used in interneuronal communication which need not be directly conscious to us (for instance, the duration of memetic codeword is about .1 seconds so that the duration of single bit is about one millisecond). In this framework the correct interpretation of the memetic codons formed by the real zero energy neutrino pairs would be as basic building blocks of our (or some lower level) belief system.

4. p-Adicity might be absolutely essential for cognition in p-adic sense. p-Adic non-determinism makes possible time like entanglement binding temporal sequences of zero energy fermion pairs to temporal wholes just like the ordinary space like entanglement binds features of sensory experience to spatial wholes. The difference between left and right brain might be

that left brain is specialized to temporal and right brain to spatial holism. In real context this binding would be possible only in special cases (zero energy neutrino pairs) and made possible by the non-determinism of Kähler action.

After these preliminaries, let us summarize the basic views about mind like space-time sheets and zero energy fermion pairs.

1. Mind like space-time sheets and the related concept of association sequence provide a geometric model for experiences having time localized content. One can identify psychological time as zero mode and understand its arrow. Mind like space-time sheets are obtained by "gluing" vacuum extremals of finite time duration to a space-time sheet containing matter and the interaction with the material space-time sheet creates the sensory representation in question. One could say that mind like space-time sheet takes a small sample of energy and various gauge fluxes from the material space-time sheet and these tiny (quantized) gauge fluxes create gauge fields giving rise to the needed simulation of the material space-time sheet. Mind like space-time sheets form in a natural manner a geometric hierarchy. One could consider also a direct mimicry of classical fields on material space-time sheets realized in terms of pairs of mind like space-time sheets such that sheets have opposite time orientations so that they can have vanishing net energy. By gluing this kind of sheet pair to the boundary of a material space-time sheet such that space-time sheet with a positive time orientation is joined to the material space-time sheet by join along boundaries bonds, one obtains sensory representation which by continuity argument can be regarded as a direct mimicry. Of course, also mind like space-time sheets can be glued in this manner to the boundaries of real space-time sheets.
2. The fermionic realization of the Boolean algebra provides fundamental model for Boolean mind. The task is to find concrete realizations for the fermionic Boolean algebra and for the quantum jumps changing the values of the Boolean algebra elements and also to find which of them could correspond to our Boolean mind.
3. Quaternion conformal fermionic state (ordinary elementary particle fermions) should be localized on mind like space-time sheets of finite time duration. Time like entanglement between fermionic states is possible only if fermions exist in finite time interval only since only this makes the required non-determinism of induced Dirac equation possible. This requires that the total quantum numbers of the fermion system vanish. Boolean mind would not carry any energy- This suggest strongly the notion of zero energy fermion-antifermion pair having vanishing total quantum numbers, in particular vanishing total energy. In standard physics context this kind of requirement does not obviously make sense but in TGD framework one can consider two different realizations of zero energy fermion pair. Note

that vanishing total energy makes it possible for real zero energy fermion pair to transform to p-adic one and vice versa and would have interpretation as transformation of cognition to symbolic expression and vice versa. Note again, that for fermions associated with the configuration space metric four-momentum vanishes identically.

4. Zero energy fermion pairs give naturally rise to Boolean algebra if fermion and antifermion reside at different space-time sheets. In fact, there are two Boolean algebras involved and the statements at the two space-time sheets can naturally be regarded as negations of each other. The quantum jumps changing Boolean statements involve annihilation or creation of zero energy fermion-antifermion pairs and do not change the total quantum numbers of the system. A unique mechanism creating zero energy fermion pairs is the splitting of a wormhole connecting two space-time sheets.
5. Zero energy boson and fermion pairs resemble virtual particle pairs of the quantum field theories. They are however real particles in the sense that in S-matrix elements they give rise to loops with the weight factors depending on the overlap of the initial and final states in these degrees of freedom rather than being completely determined by the propagator having formal interpretation as density matrix in quantum field theories. Since symbolic representations are virtual worlds, one can say that genuine virtuality is achieved in symbolic sense rather than in the sense of the quantum field theories!

In the following an attempt to understand these concepts at a more detailed level is made. The discussion is in real context, unless explicitly stated otherwise. Two realizations for zero energy fermion pairs will be considered.

1. The first realization is based on the special features of the condensed matter neutrinos a la TGD. The energy of the condensed matter neutrinos is negative since the  $Z^0$  interaction energy of the condensed matter neutrinos with atomic nuclei is negative and much larger than the rest mass of the neutrino. The energy of antineutrinos is positive for obvious reasons. This makes possible to realize zero energy neutrino pairs: a real zero energy neutrino pair is created in the splitting of the  $Z^0$  wormhole connecting the two space-time sheets. There are reasons to believe that this option is realized in bio-systems.
2. Second realization is more exotic. It is a trivial fact that in TGD context the energy associated with a space-time sheet can be positive or negative depending on the time orientation chosen for the space-time sheet. Hitherto the belief has been that this sign-indeterminacy has no physical significance. Along with the construction of the model for the mind like space-time surfaces came the realization that the dependence of the sign of energy on the local time orientation can have highly nontrivial consequences. The point is that for two-sheeted structures with finite time

duration, the arrows of geometric time at the two space-time sheets must be opposite and therefore energies at the two sheets can be non-vanishing and are of opposite sign but of equal magnitude since total quantum numbers must vanish!

3. In particular, the absolute minima of the Kähler action which are closed space-time surfaces, with possibly Euclidian signature of the induced metric, have finite time duration and the classical charges associated with various branches of these surfaces must sum up to zero: thus time orientations on various branches cannot be same. [Note that in the first realization time orientations are same!] This prototype model for a mind like space-time surface is thus nothing but a classical analog for a virtual boson pair created from vacuum!

Similar phenomenon occurs in the fermionic sector. One can construct solutions of the induced Dirac equation for vacuum bubble type double-sheeted space-time surfaces. The solutions describe classical fermion in time loop propagating forwards in time along the first space-time sheet and backwards along the second space-time sheet. At quantum level this timeloop corresponds to a virtual fermion-antifermion pair with vanishing net quantum numbers. The many-fermion states constructed using these pairs are excellent candidates for a fermionic representation of the Boolean algebra.

### 3.5.1 Zero energy neutrino pairs

In this case the two space-time sheets involved have same time orientation and both can be carriers of ordinary matter. The model for the condensed matter neutrinos implies that the  $Z^0$  binding energy of neutrinos in condensed matter is much larger than the mass of the neutrino so that condensed matter neutrinos have *negative(!)* energy having magnitude more than ten times larger than neutrino mass! For antineutrinos the the interaction with the classical  $Z^0$  field is repulsive so that their energy is positive and much larger than the rest energy. Thus condensed matter neutrinos look as if taylor made for Boolean consciousness! Classical non-determinism is involved since the creation and annihilation of zero energy neutrino pair with zero energy is also geometric process (neutrinos correspond to  $CP_2$  type extremals!). This would mean that our Boolean mind would rely on the classical non-determinism occurring at the level of elementary particles: admittedly against the original expectations.

The most plausible mechanism producing zero energy neutrino pairs is the splitting of  $Z^0$  wormhole contacts (which are  $CP_2$  type extremals connecting two space-time sheets) such that the resulting  $CP_2$  type extremals with holes are carriers of opposite neutrino quantum numbers.  $Z^0$  wormhole contacts feed classical  $Z^0$  gauge field between two different space-time sheets. Because zero energy neutrino pairs can have zero total energy and since  $CP_2$  type extremals themselves are non-deterministically behaving objects, quantum entanglement in time direction is possible for zero energy neutrino pairs. Thus our conscious thinking could be associated with population of zero energy neutrino pairs of

finite time duration dispersed around space-time surface representing brain so that the idea about four-dimensional brain is realized. This does not necessarily mean that the presence or absence of the pair corresponds to truth value true/false. It turns out that the spin direction of the zero energy antineutrino is more plausible candidate for representing truth value or binary digit.

The space-time sheets associated with the regions, where electronic or neutrino conductivity is broken are the most natural seats of reflective mind [J1, J2, J3]. The pair of sheets in question corresponds to cell and endoplasmic membranes (filling the cell in accordance with area maximization!) having  $k = 151$  and the sheet at which neutrinos suffer primary condensation, most probably  $k = k_Z = 169$ . This is the space-time sheet associated with the epithelial sheets consisting of two cell layers and forming sensory organs. The model suggests very strongly that  $Z^0$  wormhole BE condensates associated with ( $k = 151, 169$ ) space-time sheet might be crucial for the functioning of the brain and play a role analogous to electromagnetic wormhole BE condensates associated with the pair ( $k_1 = 149, k_2 = 151$ ). Gap junction connected groups of neurons, glial cells and also the epithelial sheets associated with the nuclei of brain would form structures consisting of weakly coupled  $Z^0$  wormhole superconductors and the creation of zero energy neutrino pairs would provide us conscious information about the state of  $Z^0$  superconductor.

The presence of the stripe like structures in cortex resembling defects of superconductor of type I suggests that also the pairs ( $k_1 = 169, k_2 > 169$ ) sheets appear as defects of neutrino superconductor and that thinking might be possible also at these space-time sheets. Even the entire cortex seems to be a folded membrane like structure maximizing its surface area and hence analogous to a defect in superconductor of type I near criticality (of course, there are many other good reasons for area maximization!). This would make possible physical realization abstractions as association sequences of association.... sequences (thoughts about thoughts). The low density of zero energy neutrino pairs associated with these space-time sheet pairs would explain why abstract thinking seems to be quite rare(!).

Negative energies for condensed matter neutrinos are due to the small mass of the neutrinos: for electrons similar mechanism does not work in condensed matter length scales. Rather remarkably, TGD predicts that all the neutrino species have suffered topological condensation on the p-adic level and have very nearly equal masses. The nearly equal values of neutrino masses is more or less a surprise since charged leptons and quarks tend to condense on different space-time sheets. The explanation for this peculiar exception from rule is that the condensation on same p-adic level however maximizes the reflective abilities of bio-systems since the number of the possible Boolean statements is  $2^{3N}$  rather than only  $2^N$  if each neutrino possesses effectively  $N$  possible states. It might be even that this 3-fold degeneracy makes possible 3-dimensional thinking since  $M = 2^N$  values of each spatial coordinate could be represented by  $2^N$  different neutrino states so that  $3N$  many neutrino states could provide a coordinatization of  $M^3$  points of a lattice with side  $M = 2^N$ . The fact that the neutrinos of different generations have slightly different masses, could perhaps bring in the

necessary symmetric breaking making it possible to distinguish between different coordinate directions.

There is also a second remarkable exceptional feature related to  $k = 169$  space-time sheet. p-Adic length scale hypothesis, which can be deduced from black hole elementary particle analogy by requiring that also the radius of elementary particle horizon is p-adic length scale, predicts that allowed p-adic primes are of form  $p \simeq 2^k$ ,  $k$  power of prime.  $k = 13^2 = 169$  is the only power of prime in the length scale range extending from electron length scale to length scale of solar system so that the length scale of the epithelial sheets is indeed exceptional! What makes this length scale even more exceptional is that  $k = 169$  together with  $k = 167$  gives rise to p-adic length scale pair related by scaling by factor two. Twin pairs of p-adic length scales are very common in the range of the biologically interesting length scales and seem to correspond to biologically important length scales. Taking into account that the model predicts correctly the length scale at which reflective consciousness emerges, it is perhaps needless to emphasize how unique the role of the elusive neutrinos, usually thought to be a mere nuisance without any imaginable purpose in the physical world order, would be. Without neutrinos there would be conscious intelligence, at least in the form familiar to us!

The original motivation for identifying neutrinos as associated with the reflective level of our consciousness was based on the metaphor of thinking as inner speech: the motivation was the identification of the quantum correlate of auditory experience as neutrino pair BE condensate. One can however criticize this metaphor. It seems that language can be realized as association sequences related with practically any sensory quale: for instance, sign language is based on vision and persons who are both blind and deaf learn to use direct touch as communication tool. Therefore the conclusion that our thinking is at the fundamental level related to any particular sensory quale, could be too strong. As a matter fact, it turns out that there *is* very close relationship between thought and speech although the original identification of neutrino Cooper pairs as the quantum correlate of hearing is probably wrong.

### 3.5.2 General model for Boolean mind based on zero energy neutrino pairs

In this picture one ends up to a concrete model for our Boolean mind.

1. A simple model for Boolean mind associated with neutrinos follows as an immediate consequence. The temporal sequences of temporally localized many particle states consisting of zero energy neutrino pairs represent logical statements, which state something about space-time surface in the limit when zero modes determine the many particle state completely (at least in statistical sense). These temporal sequencing does not however correspond to a sequence of logical implications but rules about about the dynamics of space-time surface. Rather, logical statements could be regarded as self cascades  $A \rightarrow B \rightarrow C\dots$  in which self  $a$  representing logical

statement is created first, then sub-self  $b$  of  $a$  is created and so on... If sub-selves correspond to different values of p-adic prime, this requires that neutrinos are condensed on several space-time sheets. Logical causation is realized as time ordering for the moments of wake-up for sub-selves and also as set theoretic inclusion:  $A$  implies  $B$  if  $b$  represents sub-self of  $a$ . Logical consistency is automatically guaranteed since the premises of logical deduction change at each step.

2. The sequences of many-particle states of zero energy neutrino pairs located around different moments of geometric time (different mind like space-time sheets) could be also regarded as statements about evolution of geometric space-time so that one can say that  $A \rightarrow B...$  would describe temporal causation and statement about dynamical evolution of 3-surface. The interaction with the surrounding world should gradually lead to a selection of causation sequences appearing in the superposition and to a model for the time evolution of space-time surface. Also a close connection with the development of linguistic skills is suggestive since neutrino Cooper pairs are the quantum correlate of the auditory experience in TGD framework.
3. The density of the zero energy neutrino pairs is very probably determined by the density of the  $Z^0$  wormhole BE condensate and could characterize the general state of alertness in various parts of brain. The average temporal distance  $\Delta T$  between zero energy neutrino pairs characterizes the temporal resolution of the conscious experience. In a similar manner, the average spatial distance  $\Delta L$  between the pairs defines the spatial resolution of the conscious experience. The information content of the conscious experience can be related to the total number of the zero energy neutrino pairs in the region giving rise to the quantum jump. One can immediately understand the differences between right and left brain hemisphere in terms of distribution of the zero energy neutrino pairs. For instance, if  $\Delta T$  is smaller in the left brain hemisphere than in the right hemisphere, one can understand why left brain is better in task involving precise temporal ordering of events. Similar conclusion applies to  $\Delta L$  and skills requiring spatial thinking. The fact that right brain has better emotional skills, could be understood if the density of the zero energy neutrino pairs is larger in the limbic system of the right hemisphere.

One can in fact go even further and construct a model for the neutrino based cognition consistent with some basic quantitative facts about brain consciousness [L1].

1. The simplest possible model for the abstraction process leads to the so called Combinatorial Hierarchy of 'genetic codes' labelled by Mersenne primes  $M(n+1) = M_{M(n)}$  given by primes 2, 3, 7, 127, ... Ordinary genetic code corresponds to the level 127 and next level corresponds to the level  $M_{127} = 2^{127} - 1$ . This prime corresponds to electron length scale and to secondary p-adic time scale  $T_p^{(2)} = p \times T_{CP_2}$ ,  $T_{CP_2} \simeq 10^4$  Planck times.

This time scale corresponds to .1 seconds, which is the duration of our self defining the psychological moment of time appearing very frequently as the basic time scale of brain related phenomena!

2. Memetic code consists of sequences of 126 binary digits. If these digits correspond to arrays of zero energy neutrino pairs, the duration of single zero energy neutrino corresponds to  $T \simeq .8$  ms. This time scale is the geometric average of the primary p-adic time scales  $T(239) \simeq .55$  ms and  $T(241) \simeq 1.1$  ms forming a twin pair. Millisecond time scale is indeed the time scale of the nerve pulse!

One must be however be cautious: actually the typical duration of nerve pulse is around 2 milliseconds and nerve pulse patterns seem to code data by frequency coding rather than by a temporally precise binary code. It might be that these time scales relate to neuronal membrane oscillations rather than nerve pulse patterns and that nerve pulse patterns code for a degenerate form of memetic code, most naturally 64 bit genetic code. Be as it may, the basic time scales of conscious brain result as predictions of the model of the abstraction process combined with the p-adic length scale hypothesis.

The first guess is that temporal sequences of zero energy neutrino pairs code Boolean thoughts. In the simplest model the spin of zero energy neutrino codes for the two truth values. A more realistic model assumes that the time varying direction  $Z^0$  magnetization of antineutrinos at the cell membrane space-time sheet represents memetic codons. This model conforms with the general ideas about how quantum cognitive representations are realized.

### 3.5.3 Zero energy fermion pairs associated with time loops

The second realization of zero energy fermion pairs is based on the possibility of time loops. In this case fermionic degrees of freedom can correspond to interior of the space-time surface and the signature of the induced metric could be either Euclidian or Minkowskian whereas for zero energy neutrinos  $CP_2$  type extremal has Euclidian signature.

#### 1. Mind like space-time surfaces

The original intuitive picture about mind like space-time surfaces was as space-time sheets of finite time duration glued to a material space-time sheet having infinite time duration: gluing was performed by # contacts (tiny wormholes feeding gauge fluxes between the space-time sheets). Also it was thought that space-time surfaces with finite duration are necessarily vacuum extremals and that gluing to the material space-time sheet changes them to non-vacuum extremals. It came as surprise that also *non-vacuum* extremals of *finite duration* can be considered. The point is that the components of four-momentum currents given by

$$T^{\alpha k} = T^{\alpha\beta} \partial_\beta m^k \sqrt{g}$$

are proportional to the gradients of the standard Minkowski coordinates ( $m^k$  denote the standard Minkowski coordinates and  $T^{\alpha\beta}$  denotes the energy momentum tensor of the Kähler action). This implies that time components of these currents change sign, when one changes time orientation, that is uses  $-x^0$  instead of  $x^0$  as a time coordinate for the space-time sheet. For a two-sheeted space-time surface consisting of two space-time sheets glued together, the global time-orientability implies that time must flow in different directions at the two 4-surfaces involved.

This in turn means that the field equations associated with the Kähler action, which are simply conservation laws for various isometry currents, could allow as their solutions 4-surfaces with a finite time duration and with the property that the two space-time sheets involved carry opposite classical isometry charges. These surfaces are analogous to pairs of virtual bosons of quantum field theories created from vacuum and having vanishing net quantum numbers. A very attractive interpretation of these structures is as a prototype of a mind like space-time surface. Obviously one can glue these sheets to material space-time sheets. It could be also possible to glue single space-time sheet of finite duration to a material space-time sheet to obtain a solution of the field equations: in this case mind like space-time sheet could carry either positive or negative energy depending on its time-orientation.

This scenario makes sense only provided it is possible to satisfy the field equations at the end points of the double sheeted structure. The basic problem is to find mechanisms making possible the transfer of energy and gauge charges between space-time sheets. There are two basic mechanisms.

### 1.1 Wormholes

Wormhole contacts (# contacts) feeding gauge fluxes between space-time sheets provide a possible realization for the transfer of gauge charges. mind like space-time sheet simply takes a small "sample" of the gauge charge density at the boundaries of the material space-time sheet. This sample of gauge charges and gauge currents serves as a source for gauge fields giving rising to the desired sensory representation. It is not however clear whether energy transfer through wormholes is possible. The reason is that wormholes correspond to space like 4-surfaces whereas energy momentum vector is time like vector and the intuitive picture identifying four-momentum as a vector tangential to the orbit of the particle seems to be in conflict with the possibility of the energy transfer.

In standard Minkowski coordinates energy momentum current is of the form  $T^{\alpha k} = T^{\alpha\beta} \partial_\beta m^k \sqrt{g}$  .

1. The first problem is that at the throat of the wormhole, defined as the 3-surface at which metric signature changes,  $\sqrt{g}$  vanishes if space-time sheet has Minkowskian signature. This requires that some components of the energy momentum tensor diverge at this surface. This is what is expected to happen since index raising is performed by the contravariant components of the induced metric tensor and some of them diverge at the throat of the wormhole.

2. Energy current ( $T^{\alpha k=0}$ ) is proportional to the gradient of the Minkowski time coordinate  $m^0$ . One can choose the coordinates in such a manner that  $m^0 = f(x^0)$ . It seems that wormholes can transfer the energy between two space-time sheets having finite time duration for which time flows in opposite direction: the gradient of  $m^0 = f(x^0)$  must change sign inside the wormhole and therefore  $f(x^0)$  must have vanishing derivative at some 3-dimensional surface  $X^3$  inside the wormhole. The energy densities at different sides of this surface must become infinite with different sign but the magnitudes of the energy densities must become same at  $X^3$ . Under these conditions the energy densities sum up to zero at  $X^3$  as they should. If one allows edge in the wormhole then energy densities remain finite and have opposite sign at the edge.

### 1.2. Gluing two space-time sheets together along their space like boundaries

One can also glue space-time sheets together along regions associated with their boundaries. The formation of join along boundaries contacts, which serves as a necessary prerequisite for the formation of macroscopic quantum systems, provides a representative example of this. One can however consider also the possibility that gluing takes place along *space like* (!) parts of the space-time boundary. For vacuum extremals with finite time duration the moments of "birth" and "death" indeed correspond to space like boundaries. If isometry currents remain finite everywhere, the surfaces must be glued to each other along space like 3-edges. The discontinuity of the derivative of  $f(x^0)$  is not a problem since field equations reduce to the conditions stating that isometry currents are continuous at the edge. If edges are not allowed, isometry currents must become infinite at the surface at which  $f(x^0)$  has vanishing derivative just as in the case of wormholes.

Admittedly, in case of Minkowskian signature of the induced metric the unavoidable singularity might make the realization of mind like space-time sheets in this manner impossible. The induced metric can have Euclidian signature also for space-time sheets expressible locally as graphs of maps from  $M^4$  to  $CP_2$ . Since Poincare invariance is realized at the level of the imbedding space, there is no deep reason forbidding non-vacuum space-time surfaces of this type. In particular, the space-time sheets can be closed (no boundaries) and in this case they are automatically vacua globally although the classical charge densities associated with various sheets can be (and probably are) non-vanishing. In this case it might be possible to have completely regular time loop like solutions representing pairs of mind like space-time sheets. Since also  $CP_2$  type extremals possess an Euclidian signature of the induced metric, one could consider the possibility that matter and mind quite generally correspond to Minkowskian and Euclidian signatures of the induced metric respectively!

### 2. Zero energy fermion pairs in time loops

A possible realization of the fermionic Boolean algebra relies on fermion-antifermion pairs such that fermion and antifermion reside on separate space-

time sheets. This realization makes possible to change the values of the Boolean statements by the annihilation or creation of fermion-antifermion pairs. The optimal situation is achieved if the net quantum numbers, in particular the total energy of the pair, vanish. In this case the physical realization for the Boolean mind involves no energy in accordance with the intuitive idea that mind is in some sense something "nonphysical". The idea of mind like space-time surfaces as a classical analog for virtual bosons indeed generalizes to the fermionic sector.

For simplicity, consider a pair of space-time sheets glued together to form a double-sheeted structure. In principle, Dirac equation for the induced spinors allows global solutions also in this case. The conservation of the isometry currents for various modes of the Dirac equation at the ends of the space-time sheets can be treated just as it is treated in the bosonic case. Again it can happen that the density of some isometry currents, in particular energy current, associated with a given fermion mode diverges at the 3-surface, where the function  $m^0 = f(x^0)$  achieves extremum value. zero energy fermions rotating in time loops are expected also in the case of a mind like space-time sheet glued to a material space-time sheet. Note that for space-time surfaces which are closed (without boundaries) absolute minima of Kähler action with induced metric having Euclidian signature, there are no problems with regions at which signature of induced metric changes and one can have modes of induced spinors satisfying classical Dirac equations.

Quantum mechanically zero energy fermion pairs are analogous to virtual fermion-antifermion pairs created from vacuum and physical representations for the elements of the fermionic Boolean algebra representing thoughts are created by oscillator operator pairs. Rather interestingly, the states for the fermionic representations of the Boolean algebra occur always as pairs with statement and its negation residing at different space-time sheets. One could perhaps say that two-sheetedness is necessary in order to create the idea of the logical negation at the level of conscious experience.

A criticism against above argument is that it is based on classical Dirac equation and not formulated at the configuration space level. The fermions associated with configuration space metric are assumed to have a vanishing four-momentum automatically. It is not clear how this relates to the induced Dirac equation which gives additional constraint and which also at least formally allows to assign four-momentum to the solutions of the Dirac equation.

Second objection is that robustness and stability require a realization of cognitive representations using many-particle systems [H8]. Therefore single fermion should be replaced by a magnetized ensemble of fermions and the direction of magnetization would represent Boolean yes and no.

### 3.5.4 Is there empirical evidence for negative energy fermions?

Is there any empirical indications for the existence of negative energy fermions? There are several reports about various anomalies associated with rotating magnetic systems, and the TGD based explanation for the anomalies reported by

Godin and Roshchin in [42] involves in an essential manner the generation of negative energy space-time sheets at which a population of negative energy particles is generated. The explanation of the anomalies leads to suspect that, besides negative energy photons and gravitons, also negative energy partners of ordinary ions might be present on negative energy space-time sheets.

## 4 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 the physical death. What happens in the physical death? Is self preserved in the physical 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 physical 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 is chronological sequence of various points of view rather than final summary. Also mutually conflicting points of view are considered.

The localization in zero modes occurring in each quantum jump allows to identify evolution as a gradual increase of the  $p$ -adic prime characterizing the Universe: the natural ethics identifies good deeds as the selections promoting evolution and selves act as moral agents.

The cosmology of consciousness, the concept of self and the concept of mind like space-time sheet provide the building blocks needed to construct models for what might happen in the physical death. One can also imagine models for reincarnation. Even the conditions under which the law of Karma could be realized, can be discussed.

One of the purely  $p$ -adic aspects of NMP is the possibly of  $S \leq 0$  selves (selves whose all subsystems have positive entanglement negentropy). These selves seem to represent "asymptotic selves" and hence could provide a model for "liberated souls" in state of cognitive enlightenment. Amusingly, "liberated souls" have a direct geometric counterpart as closed (vacuum) absolute minima of Kähler action in accordance with quantum-classical correspondence principle, which has gradually gained the status of the basic heuristic guiding principle of

the TGD inspired theory of consciousness.

The section is concluded with a discussion about what might expect us after the physical death, now from the point of quite recent view about psychological time as characterizing the front of p-adic-to-real transition representing volitional actions. This identification provides rather concrete view about consciousness after death and is forced by very general consistency conditions. The fusion of these ideas with the other views discussed in the section is not even attempted and it remains to find out in which aspects various ideas are mutually consistent and which are not.

#### 4.1 Quantum ethics very briefly

Localization in zero modes implies p-adic evolution as a gradual increase of the infinite p-adic prime characterizing the entire universe. This evolution means also the evolution of consciousness. p-Adic evolution has rather surprising consequences. For instance, it seems that one could even understand the origin of moral.

Selves have free will and subjective past and hence can act as moral agents. Volition corresponds basically to the selection between various degenerate absolute minima of Kähler action characterized by different infinite p-adic primes. Infinite p-adic primes decompose in a well defined sense to finite primes characterizing material and mind like space-time sheets and increase or reduction of infinite prime is induced from that of a finite prime so that global evolution is induced by local evolution. The reduction of evolution to local evolution implies that our choices, although are between finite p-adic primes, affect global evolution, which is much more general concept than biological evolution.

The identification of p-adic space-time sheets as representations for intentions and the identification of p-adic-to-real phase transitions as transformations of intentions to real actions gives additional concreteness to this vision. The identification of the psychological time as the value of the geometric time characterizing the phase transition front at which p-adic-to-real phase transitions mostly occur, allows to understand psychological time as the time value around which volition is strongly concentrated.

The ethics is simple: evolution is the good thing. Therefore the increase of  $p$  is good and reduction of  $p$  is bad. There are two options for identifying moral choice: either the  $p$ :s characterizing initial and final sectors  $D_p$  are compared or the  $p$ :s characterizing various possible final state  $D_p$ :s are compared. The latter option does not look so plausible since it predicts that our moral choices are between infinite number of possible alternatives. In accordance with Hume's law values (in fact all qualities) belong to the realm of subjective existence (quantum jumps) rather than being properties of the objective world (quantum histories).

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. There is 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.

## 4.2 Ageing and death

Quantum jumps inside self give rise to dissipation so that one can say that physical ageing is the price paid for having self. More concretely, the self representing body image becomes entropic since the corresponding statistical ensemble grows in size quantum jump by quantum jump. The process of ageing could be a process analogous to the process of getting drowsy and falling asleep but in much longer time scales. The process would involve generation of temporal entanglement of sub-selves of self with larger selves. Sub-selves presumably define also conscious clocks. If the average number of quantum jumps per geometric time for sub-selves representing conscious clocks is reduced, geometric time is experienced to flow with increasing rate towards the older age. This could be also due to the increasing role of macro-temporal quantum coherence: periods spend in a state in which quantum jumps effectively fuse to single quantum jump could be experienced as single moment of consciousness. The opposite situation would result in the experience of becoming bored.

Perhaps the process of ageing could be a process of personal growth (in a rather concrete sense!). The temporal entanglements generated between real selves and larger real selves (real self is labelled by the p-adic prime characterizing the p-adic topology which it is near criticality to transform to) would give rise to larger temporal selves and the metaphor "awakening" would thus be much more than a metaphor. Person would spend more and more time in extended state of consciousness and in death finally leave the confines of the physical body. This would make possible the evolution of selves continuing after death to higher levels of conscious existence. This picture is rather optimistic. Of course, one must also consider the possibility that the evolution of self is not continuous growth! The fact that the individual development of many people seems to be a process of continual abstraction indeed that physical 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 the physical death.

Universe is full of selves and one cannot say anything definite about the fate of self after death unless one can decide which self can be regarded as the continuation of self before death. Since self has 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 geometric memories of self before death. For instance, mental image of self could

entangle with a higher self with subjective memory of order of lifetime of self. In this extended state of consciousness self could experience the subjective past of self's space-time sheet and associate it with self's recent mind like space-time sheet. Note that this kind of mechanism could also explain why it is possible that I regard it obvious that I existed yesterday although my bodily self slept over night. Of course, the very fact that we can remember our yesterday self although our subjective (short term) memories seem to be of order few seconds, suggests that it is also possible to remember something about previous life, at least for some time after the death: we actually die all the time!

The basic idea of most religions is that people must atone for their sins sooner or later. Something akin to the law of Karma could indeed be realized. The nature of the self carrying my memories after my physical death defines my reincarnation. This self can be either lower or higher in the hierarchy of selves than my self before death depending on the value of the p-adic prime characterizing its space-time sheet. Note that personal p-adic evolution is in accordance with quantum-classical correspondence principle and p-adic evolution at the level of configuration space. Now the personal p-adic prime could however be associated with real space-time sheets in the manner already described. If one accepts that there is an infinite hierarchy of selves with free will, one cannot exclude the possibility that the selves at the same or higher levels of the hierarchy are willing to affect our fate after death just like we can affect the fates of our individual cells and mental images (however unpleasant this possibility might sound in the ears of the hedonistic modern man!).

Quantum-classical correspondence principle suggests that the endless self-evolution of universe could correspond to an endless self-evolution at the level of individual. If self and mind like space-time sheets are firmly associated with each other, the question about the reality of physical death reduces to the question about the fate of the "personal" mind like space-time sheet after death. Geometrically the fate of the self after death could perhaps be described as a formation of join along boundaries bonds between the mind like space-time sheet of self and the mind like space-time sheet of self at some level of the hierarchy of selves.

### 4.3 Death as disappearance of the mental image representing the physical 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 bodily death.

1. Our mental images actually correspond to ELF and even ULF MEs of size of order  $L \sim \lambda = c/f$ , where  $f$  is the frequency in question (not above EEG range), so that the sizes of these mental images are measured using Earth size as a unit. Sizes of MEs of order light life are possible.

2. The ultimate sensory representations are realized on the magnetic sensory canvas provided by magnetic flux tube structures of similar size, so that we have magnetic body providing sensory representation of the physical body and external world [H4]. Our magnetic self very probably survives in the physical death simply by the conservation of the magnetic flux and large size of the magnetic selves forbidding the disappearance of the magnetic self.

Under these assumption our afterlife body would consists of the magnetic body plus MEs possibly surviving the death of the so called physical body. The only difference as compared to the life before death would be that the sensory and mental images representing the physical body (sub-selves) would disappear and the attention of our self would be directed to something else. Near death experiences indeed support this view [I3]. 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 physical body and uses it as a sensory and motor organ. This new physical body could be plant, animal, human, or perhaps something else. In this picture the metaphor about physical 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 self's mind like space-time sheet and associate it with self's recent mind like space-time sheet. Note that this kind of mechanism could also explain why it is possible that I regard it obvious that I existed yesterday although my bodily self slept over night. This picture is consistent with the reported ability of some children to remember their past lives.

#### 4.4 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. 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.

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!

Indirect support for the survival of mind like space-time sheets after death (and for reincarnations) comes from rather unexpected direction. The phenomenon of phantom DNA suggesting that mind like space-time sheets associated with DNA remain in the chamber which contained DNA: in the experiments of Poponin [41] the signature of phantom DNA is its interaction with laser light. For TGD inspired explanation of the phenomenon see [J5]: two peculiar phenomena with a common explanation”. The claimed successes of homeopathy could also have explanation in terms of 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 and that these mind like space-time sheets are able to affect the sickness. The law of similarities could have something to do with the mechanism involved.

Some support for the extension of self in death is provided by near death experiences. 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 [I3].

#### **4.5 What ‘liberation’ might mean?**

The strong analogies with Buddhism encourage to ask whether the TGD inspired quantum counterpart for the Buddhist concept of liberation might make

sense. Quantum-classical correspondence principle suggests that the endless p-adic 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 temporal transformation to a higher level of consciousness.

In the real context selves having only single mental image 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.

Self can have also cognitive mental images or be a cognitive mental image. An attractive identification of these mental images is as p-adic  $S \leq 0$  selves discussed in [H2].  $S \leq 0$  selves can be defined as selves for which all subsystems have  $S \leq 0$  entanglement. It is easy to see that in case of two entangling p-adic systems  $S = 0$  entanglement is unstable unless the number  $n$  of entangled states is smaller than  $p$ . If it is larger than  $p$ , NMP forces quantum jump to a state containing  $p^N k < n$  entangled states with identical entanglement probabilities. One might think that 'liberated soul' could possess this kind of cognitive mental image or mental images interpretable giving rise to experience of enlightened understanding. Also this state is in principle unstable against unitary process. Perhaps one could say that 'liberated souls' get at least momentarily rid of the wheel of Karma resulting from attachment to sensory experiences.

#### 4.5.1 Liberation experience as "cosmic consciousness"

Liberation experience might also relate to the experience of "cosmic consciousness". 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 bound state entanglement with some other system. This can happen for any subsystem of Universe but not for entire Universe enjoying an eternal state of consciousness. The state of cosmic consciousness thus means being a self without ego. 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. This notion might however have a rather literal meaning. If p-adic- and real-rational imbedding space points are related via the identification of common rational points, p-adic space-time sheets typically have an infinite size with respect to the real topology since p-adically infinitesimally small distances necessarily correspond to infinite real distances. In this cognitive sense cosmic consciousness would have surprisingly concrete meaning. On the other other hand, if rationals belonging to various p-adic number fields are identified via the map  $r/s \rightarrow I(r)/I(s)$ , where  $I$  is canonical identification, situation changes and p-adic and real sizes correspond to each other. This identification respects rational variants of various symme-

tries only in the limit  $p \rightarrow \infty$ . These widely different options correspond to two different manners to fuse real numbers and various p-adic number fields to a larger book like structure by gluing these number fields together along common rationals (they gluing could be performed also along common algebraic numbers).

#### 4.5.2 'Liberated souls' as $S \leq 0$ selves

The formulation of NMP in p-adic context is not totally fixed yet.

1. In the original formulation the real counterpart of the p-adic entanglement entropy was defined by canonical identification and was automatically non-negative.
2. It has however turned out that the identification of the real counterpart of p-adic negentropy via the identification by common rationals is much more natural option if entanglement coefficients are rational numbers so that entanglement probabilities are algebraic numbers. Most importantly, entanglement negentropy is positive for p-adic quantum computer type states. Among other things, this allows to understand what it is to understand.

$S = 0$  selves are very interesting limiting case.

1.  $S = 0$  selves are defined as p-adic selves for which all subsystem-complement pairs have vanishing entanglement entropy. This means that entanglement probabilities have unit norm.  $S = 0$  selves are possible for both definitions of the real counterpart of the p-adic entropy but for the option b)  $S = 0$  self is stable against self measurement only provided the number of the entangled states is smaller than  $p$ .
2. If the density matrix is the fundamental observable, the allowed quantum jumps of  $S = 0$  selves occur to the subspaces of the eigenspaces of the density matrix of some subsystem-complement pair and lead to  $S = 0$  a quantum computer type state.
3. If the p-adic entropy operator is the fundamental observable, NMP says nothing about the behavior of  $S = 0$  selves. This in principle allows  $S = 0$  selves to have extended free will. NMP does not specify the subsystem performing the quantum jump: the density matrix of any subsystem can be measured.  $S = 0$  self can also refuse to perform any quantum jump and experience the reality as it is. Using Buddhist terminology, one could call  $S > 0$  entanglement as attachment whereas  $S = 0$  entanglement could perhaps be identified as a state of pure love and  $S < 0$  entanglement as a state of understanding (and pure love).

In the real context NMP forces a complete selection of final state even when the density matrix is degenerate unless bound state entanglement is in question:

this has interpretation as a necessity to select between logically inconsistent alternatives. In quantum jumps to entangled state this kind of choice is not performed: final state is like the superposition of dead and living Schrödinger cat. Therefore  $S < 0$  entanglement would provide the p-adic loophole allowing to cognitively experience what it is to be entangled. Zen Buddhists experiences are often characterized as states of consciousness in which no selection is made between mutually exclusive alternatives. Hofstadter has described this aspect of Zen in enjoyable manner in his book "Gödel, Escher, Bach".  $S \leq 0$  property of self means absence of entropy and this could be interpreted as the absence of illusions and even as genuine cognitive information and understanding. The absence of illusions and of dissipation and many-valued logic of subjective experience, and perhaps even extended cognitive free will in case of  $S = 0$  selves, are features which make  $S \leq 0$  selves rather special creatures and one could perhaps call them "liberated souls".

What is exciting is that  $S \leq 0$  self can correspond to a fixed point of evolution dictated by NMP just as thermal equilibrium is the fixed point of evolution dictated by the second law of thermodynamics. This kind of selves could be generated as a result of repeated quantum jump in which various  $S > 0$  subsystems of self quantum jump to a state with  $S \leq 0$  entanglement. The probability that this kind of quantum jumps occur is large since the p-adic probabilities involved have unit p-adic norm. Hence  $S \leq 0$  selves could quite well correspond to asymptotic selves. Of course, the unitary process  $U$  can destroy  $S \leq 0$  self or even entangle entire  $S \leq 0$  self with a larger self. In case that  $S \leq 0$  property is destroyed, self can however perform quantum jumps which re-establish  $S \leq 0$  property and by NMP these quantum jumps have high probability of occurrence.

### 4.5.3 'Liberated souls' geometrically

One can wonder what might be the geometric counterpart for a 'liberated soul'. Buddhas are typically described as jovial persons staring reflectively at their own navel. Amusingly, quantum-classical correspondence principle suggests that  $S \leq 0$  selves correspond geometrically to closed (sic!) absolute minima with finite time duration. The fact that these surfaces are vacua suggests that universe could be full of  $S \leq 0$  selves in the state of cognitive Nirvana!

1. These absolute minima are automatically classical vacua globally and most naturally possess globally Euclidian metric. Kähler action is negative for Euclidian signature of metric so that absolute minimization of Kähler action favors the formation of these objects.  $CP_2$  type extremals provide simplest examples of this kind of vacua but the size of closed absolute minima can very probably be arbitrarily large. Note that these surfaces are very much like vacuum bubbles of quantum field theory. By vacuum property the inertial mass of liberated soul vanishes. Also the gravitational mass must vanish by a classical, non-relativistic argument: gravitational mass corresponds to a gravitational flux expressible as a surface integral

and the gravitational fluxes from the two space-time sheets must cancel each other. Presumably this holds true also for the topologically condensed Buddhas.

2. Extended free will corresponds geometrically to the fact that the association sequences associated with closed absolute minima can contain arbitrary many 3-surfaces with time like mutual separations.  $S = 0$  selves can remain selves only if they are able to remain unentangled with the external world. The geometric counterpart of the entanglement is the formation of join along boundaries bond between boundaries of self and of external world. The fact that closed vacuum absolute minima cannot form join along boundaries bonds, suggests that closed absolute minima, which are automatically vacua, give rise to stable  $S = 0$  selves: note that these mind like space-time sheets would be purely "mind like" in accordance with the basic idea about liberation as liberation from confines of material existence. This identification is indeed consistent with the idea that liberated soul should not have painful sensory experiences, should be free of all the daily troubles caused by the gravitational force and dissipation, and be able to preserve the state of  $S = 0$  entanglement.
3. Closed absolute minima can also contain zero energy fermion pairs (any solution of induced Dirac equation represents this kind of pair) so that also reflective consciousness is possible and in fact all fermions can contribute to it unlike in case of the ordinary matter-mind type selves for which only zero energy neutrino pairs seem to provide realization of logical thought. The solutions of the induced Dirac equation representing zero energy fermion pairs represent the fermionic counterparts of vacuum bubbles. Physical constraints give no upper bound for the density of the closed absolute minima of Kähler action and this raises the possibility that the Universe is full of enlightened Buddhas and consciousness as we know it is only an exotic and very special form of consciousness!
4. The construction of infinite primes gives additional support for the identification. Infinite primes of form  $X \pm 1$  do not correspond to any decomposition of the space-time surface to material and mind like space-time sheets. There is however natural interpretation of 1 as set of closed absolute minima representing enlightened selves in the state of "one-ness"! "1" is factor in the finite part of any infinite prime so that this factor would represent quite generally closed vacuum extremals in Buddha state!

#### 4.5.4 How to observe 'liberated souls'?

Even liberated souls are physical objects and one can ask how to observe them. Liberated souls have vanishing classical charges and extremely weak direct interactions with the material world. The interaction of the coherent photons with the charged # contacts possibly associated with topologically condensed souls could however make possible scattering of the coherent photons from souls such

that part of the energy momentum of the topologically condensed photon goes to the material space-time sheet. Charged # contacts couple to the difference of the gauge potentials describing topologically condensed photons of the coherent light on the two space-time sheets [J5]. If soul has charged # contacts with a surface containing matter, one can create a beam of topologically condensed coherent light on the material space-time sheet and allow it to scatter from the soul. Also the interaction of soul's # contacts with matter ordinary matter via classical electromagnetic fields is possible. Of course, liberated souls need not have any em charged # contacts to material space-time sheets so that interaction would reduce to extremely weak gravitational interaction of quadrupole type.

The communication with topologically condensed liberated souls is however possible via the direct subjective experience! A soul which has topologically condensed to the space-time sheet of self, is experienced as a mental image, perhaps even rather enjoyable mental image! Perhaps enlightened souls correspond to memes, pure ideas!

#### 4.5.5 Do liberated souls leave black holes behind them?

Black hole definitely represents a failure of the General Relativity. Thus it should represent also the door to the new physics. Topological evaporation, one of the most obvious implications of TGD, in turn represents something totally new, and it has taken frustratingly long time to decide whether topological evaporation should be taken seriously or not and what it really means. Therefore it would have seemed natural to try to find connection between black holes and topological evaporation. Unfortunately, the logic of discovery does not obey this kind of simple rules and it took twenty four years before I realized the connection.

If the interpretation of gravitational mass as a charge analogous to gauge flux makes sense, the gravitational mass of a completely topologically evaporated space-time sheet must vanish. If one assumes Equivalence Principle this means that also the inertial mass is vanishing and the system is 'feather-light'. Therefore the topological evaporation of a system, if it is possible without the loss of the identity of the system, would liberate system completely from the constraints posed by gravitation and other classical long range forces. The evaporated system would leave its gravitational and inertial masses to the space-time sheet from which it topologically evaporates as 'surface charges'. The evaporated system itself would carry neutralizing negative gravitational and inertial masses as surface charges at the boundary of the space-time sheet representing the system. Topological evaporation could be also partial and would lead to a partial loss of the gravitational and inertial masses. What would be left in a complete topological evaporation would be only these surface charges which still are 'seen' at the space-time sheet at which the system was topologically condensed. All information possessed by the larger space-time sheet about system's interior would be lost since the evaporated system could easily fleet to another galaxy. This information would be however still there.

This brings in mind black holes: perhaps black hole is left in a complete topological evaporation. Black hole has no hair and is characterized only by mass, angular momentum, and some charges just like also the hole(s) created in topological evaporation. The basic mystery of black hole physics is whether the huge amount of information associated with the physical configuration of the star interior is really lost in the formation of black hole or whether it is somehow preserved. In TGD framework the optimistic option would be realized: the evaporated system liberated from the constraints of gravitation and other classical long range interactions would represent, the information theoretic essence, the 'soul', of the star when it reaches its final stage of evolution. The star would not die in the sense that huge amount of information would be lost. Of course, also other systems than stars might evaporate in a similar manner and become 'liberated souls'.

What kind of mechanism could cause the topological evaporation? If the space-time sheet associated with the system is bound to a larger space-time sheet with the mediation of thread like join along boundaries bonds feeding its gravitational flux to the external world, a rapid rotation of the system might lead to the entanglement of these threads followed by a splitting analogous to what occurs in the reconnection process of magnetic field lines. This kind of process could lead to a partial loss of gravitational and inertial masses and make 'flying saucer' technology possible. There is evidence that spinning magnetic systems can lose part of their gravitational and inertial masses [42], and in [G2] these anomalies are discussed. A typical signature would be spontaneously accelerated spinning due to the angular momentum conservation. These effects depend on the direction of rotation and thus break parity conservation and the explanation of these effects involves also classical weak force in an essential manner.

UFOs might apply this technology. The strange butterfly motion of UFOs is impossible in present technologies if UFOs are really 'copper and steel' as it seems to be the case at least in case of some UFOs. No strong atmospheric recoil effects such as shock waves are observed which suggests that the inertial masses of UFOs are very small. These findings make sense if the reduction of the inertial mass due to a partial topological evaporation induced by a rapid spinning.

The plasma ball like structures often associated with UFOs might represent genuine life forms having very small inertial mass thanks to the proposed mechanism. In [N1, N2, N3] the idea that plasmoidic life forms serve as "mediums" entangling with the observer of ET and with ET is discussed and thus making possible telepathic sharing of mental images between life forms separated by an astrophysical distance. The obvious question is whether these plasmoid like structures might be "liberated souls" in the proposed sense.

#### **4.6 What after the physical death?: the vision provided by a more precise view about psychological time**

The view about psychological time as the value of the geometric time characterizing the phase transition zone around which volition is strongly concentrated

and the identification of volition as p-adic-to-real phase transition was already found to have rather non-trivial implications concerning the understanding of psychological time (see section 'More detailed ideas about psychological time'). This vision provides also quite concrete views about the nature of consciousness after the physical death. Recall that the basic concepts and ideas are following ones.

1. 4-D body which grows during the lifetime and becomes fully developed in the physical death. This state can be however unstable against real-to-p-adic phase transitions leading to deconstruction/decay processes.
2. The protein metaphor allowing to relate the growth of the 4-D body in the direction of the geometric future with the growth of a protein in mRNA-protein translation.
3. p-Adic-to-real and real-to-p-adic phase transitions as processes which allow to construct 4-D body gradually like artwork by repeated trial and error process with wrong constructions followed by deconstructions (healing process would be typical example of this). At the level of human consciousness error would mean wrong choice during 4-D growth and to un-ethical behavior.

The basic view is that physical death is only apparently an end. Natural physical death means that personal self-organization pattern becomes completed just like a protein becomes completed during the translation process. Un-natural physical death would mean that part of the plan remains un-fulfilled and the resulting structure is geometro-temporal torso. The contents of consciousness of a bodily dead self would be more or less timeless and radically different from our ordinary highly volitional consciousness getting dominant contribution from the phase transition front. Those in the phase transition front would experience the deceased as long term memories as long as its 4-D body exists.

There are several questions to be answered.

1. Is the mature 4-D body stable or does it possess finite subjective lifetime (note that this 4-D decay process has nothing to do with the physical decay process proceeding towards the geometric future although it could be initiated immediately after this process)? Polymerization metaphor supports this view but also suggests that the mature 4-D body has a finite subjective lifetime. The fact that our long term memories about the deceased are not eternal, suggests that this 4-D body decays sooner or later, at least partially.
2. If 4-D physical body eventually decays completely or partially, what is the mechanism by which it decays? Could this process occur backwards in the geometric time as a reverse phase transition changing intentions and be followed by a new phase transition giving rise to a new life? Or could it occur simultaneously along the entire geometro-temporal

span of 4-D body? Whatever the answer might be, it would seem that this process should be initiated by some seed of the phase transition and proceed then over some region of the 4-D body.

3. Could the phase transitions affect only a finite portion of 4-D body and could one consider a process in which the 4-D body is gradually built-up like an artwork via a trial-and-error process?
4. What is the role of the other selves of the self hierarchy? The stability of a protein depends strongly on its biological environment: in vivo the behavior is quite different from that in vitro. The same might hold for 4-D physical bodies. This brings in mind the fate of a cancer cell in organism. Other selves could induce a partial or complete decay of the 4-D body of self which behaves like a cancer cell and support the the survival of a 'well-behaving' 4-D body.
5. If the phase transition front is common to the members of the society, physical death is experienced by others with its usual meaning. This assumption saves from several paradoxes. But what about the counterpart of the physical death occurring in the geometric past? Is it possible at all or is it like a wound in 4-D body which is healed? It seems that a quantum jump having permanent effects is extremely improbable since it would be accompanied by infinitely large changes in the geometric future.

#### **4.6.1 Is the subjective lifetime of 4-D body finite?**

The reduced non-determinism in the geometric past does not favor the decay process so that the 4-dimensional body could be relatively stable and could perhaps be seen as an approximate geometric correlate for the subjective past which does not change at all. This does not of course exclude the gradual evolution of the 4-D body but the conscious experience during this stage of evolution would be totally different since it would receive its contents from the entire duration of the life cycle.

Quantum criticality of the TGD universe suggests that 4-dimensional self-organization patterns have a finite subjective lifetime which in principle has nothing to with geometric lifetime and could be much longer. Quantum criticality of the TGD universe suggests also that the p-adic-real quantum phase transition defining the front of volitional consciousness can occur also in the reverse direction, at least temporarily. The phase transitions and their reversals could occur in many manners and be also partial. Life as an artwork view suggests that 4-D body could be build-up gradually by making the reverse phase transition up to the critical moment of life when the wrong choice was made and starting again. One could see the unstability of the 4-D body as the basic cause of reverse phase transition so that the process would automatically lead to an increasingly stable situation leading asymptotically to what might be perhaps called a Buddha state. Of course, there is no guarantee about anything absolutely stable and entire sequence of biological lifes is possible. This

sequence of biological lives brings in mind the cycle of Karma and would be the 4-dimensional analog for cell death and regeneration.

The reverse of the p-adic-to-real phase transition would mean that the arrow of the psychological time changes temporarily. From my own 'great experience' during which I was some period of time unconscious in clinical sense I remember the fight against the reversal of time arrow. Perhaps this was actually a fight against the initiation of a process in which some actions transform back to intentions. These temporary reversals of time's arrow would provide an error correction mechanism making possible to refine the carving of the four-dimensional body.

Consider now the arguments in favor and against the view that the subjective lifetime of 4-D body is finite.

1. One signature of the 4-D decay process would be the disappearance or at least the weakening of the long term memories about the deceased resulting from the fact that there exist no 4-D body communicating these memories anymore and only secondary memories resulted in memory recall processes remain. The deceased would rather literally live as our memories. Since the memories about deceased usually tend to fade away this would suggest that 4-D body is indeed unstable. On the other hand, since the long term memories about the deceased do not disappear immediately, it would seem that the decay process does not start immediately and/or that the decay front proceeds to the past with perhaps same velocity (increment of the geometric time per quantum jump) as the growth process. Persons like Buddha who are regarded as immortal in a metaphorical sense would thus be also in a concrete sense, if not immortal, at least very longlived and live as long as the society remembers them. They could even be kept alive by the society.
2. This is not the only possible explanation. The model of long term memory [H6] predicts that there is an upper bound for the length of MEs giving rise to long term memories. The length of ME would actually correspond to the frequency of a transition in which ME is generated. According to the model of long term memory it would be a spin glass transition between two configurations of the classical gravitational field with same induce Kähler field and gravitonic ME would be in question.
3. Wernicke syndrome is a tragic loss of long term memories in which the immediate past of the patient (often alcoholic) consists only of few minutes: the destruction of mammillary nuclei is involved with this syndrome. The temporal boundary between what is recalled and what is not proceeds gradually to the direction of past during the development of the syndrome and stops to some critical moment of time. Hence the memories of the earlier life are preserved up to some critical moment. Neuroscientists would presumably say that only the ability to build long term memory representations from the sensory input is lost in the Wernicke syndrome since

mammillary nuclei are destroyed. This does not however explain why the front of lost memories proceeds to the direction of past.

A more refined explanation is that some part of the 4-dimensional body of the patient, presumably mammillary nuclei crucial for the build-up process of the sensory and cognitive representations, become unstable and decays. In terms of the protein metaphor, the polymerized protein begins to depolymerize at some moment of time and the depolymerization front proceeds to the direction of the geometric future with the same rate as polymerization. Depolymerization would proceed also to the direction geometric past until it would stop. The explanation for the loss of long term memories suggest that the 4-D body has a finite subjective lifetime.

4. Many people at high age tend to lose their long term memories gradually but the childhood memories are the most stable. This could be interpreted as a partial decay of 4-D body analogous to what could happen also in the Wernicke syndrome.

#### **4.6.2 Saints and sinners, heaven and hell**

4-D bodies form a society analogous to a cell population. The fate of the cell in the population depends on its own behavior. The fate of a cancer cell is to die whereas the survival of the healthy cells is supported by the organism. Situation is expected to be the same in the society of 4-D bodies. This suggests one possible interpretation for the Buddhist visions about Karma and for the religious concepts of heaven and hell.

If the member of society is 'saint' enjoying respect and love, it is plausible that other selves support the survival of this 4-D body and catalyze various small scale healing processes helping to stabilize its 4-D body. Thus the saint would live relatively pleasant life in a deep meditation enjoying a timeless state of consciousness and being liberated from the the cycle of rebirths.

If self is 'sinner', that is represents a destructive 4-D subsystem analogous to a cancer cell, one could imagine that the regeneration process must start from the moment when the person made the crucial wrong decision (analogous to an error in the mRNA-protein translation). This requires a thoroughgoing, not necessary pleasant, 4-D decay process analogous to a depolymerization process and proceeding down to this fatal moment of geometric time when the first wrong choice was made. This de-construction process is followed by the reconstruction phase which has as the analog a polymerization process starting again from some point of the protein. The fellow human beings of the sinner would have their psychological nows in the geometric future and from the point of view of the sinner would show very little genuine volition. Thus the geometric past would look for the sinner like a kingdom of dead experienced by a living creature whereas the full-fledged 4-D bodies would experience this kingdom of dead differently, perhaps as a heaven! Heaven and hell would be thus relative concepts.

### 4.6.3 Are reincarnations in the geometric future possible?

The simplest view assumes that the front of volition does not propagate after the physical death. One could however consider the possibility that the front of volition continues to propagate by transforming p-adic magnetic or  $Z^0$  magnetic mirror structures to real ones: volitional life would continue in electromagnetic form. This would make possible the communications of the deceased with living since the resulting magnetic mirrors could connect the deceased with the living. Since magnetic mirror structures are fundamental for the field realization of the genetic code, one can quite well consider the possibility that this process induces also the self-organization of the ordinary living matter around the magnetic mirror structures. This would have interpretation as a reincarnation. Buddhas able to resist the temptation to reincarnate would continue their life at the field level. Interestingly, the development of physics from Newtonian physics of the material bodies to Maxwellian physics of fields would mirror the evolution of consciousness from concrete biological life to life at the field level.

### 4.6.4 Are reincarnations in geometric past possible?

Usually reincarnations are thought to occur in geometric future. One could however approach the idea of reincarnation from a completely different view point. The simplest visualization for the cosmology of consciousness is as material space-time sheets populated by mind like space-time sheets drifting gradually to future. Thus also the material space-time sheets representing the life history of my body should be populated by these mind like space-time sheets and unless they are mutually entangled and are at the same level of self hierarchy, this train of mind like space-time sheets wandering through time can be said to represent my re-incarnations as long as the my physical body exists in the geometric past.

The fact that the contents of sensory experiences are sharply localized in geometric time, gives strong constraints on this picture. Sensory space-time sheets can have duration of only few seconds whereas "my" mind like space-time sheet could have much longer duration, even of order lifetime. If sensory space-time sheet populate "my" space-time sheet having much longer time duration, sensory space-time sheets can spend only few seconds in the state of "whole-body" consciousness (pure experiencing). After that sensory self must either fall asleep or go to a mode of "ordinary consciousness" in which it decomposes to sub-selves and analyzes its experience. This analysis period might be related to long term memories.

One could claim that the me's of the geometric past are genuine re-incarnations only if there is continuity of subjective experience involved in the sense that reincarnation remembers something about its former life in the geometric future. Some old people relive their childhood and youth. A possible explanation is that the space-time sheet representing new copy of self in the geometric past is entangled with the recent self and makes possible to experience new childhood (time like entanglement is indeed possible in TGD framework). In this process these pseudo "memories" would become more and more real and "real-

ity” would become more and more like memories! This picture would allow the possibility of a smooth transition in which the ”center of mass” psychological time of self gradually shifts to geometric past without any gap. Young child could still have subjective memories about the events in the geometric future: these memories would of course be experienced as belonging to subjective past. This sounds somewhat strange but actually it is not obvious which parts of our normal experiences receive their information contents from geometric future. It is the phase transition front for the transformation of intentions to actions which defines psychological time and this picture would mean that a new phase transition front is propagating in the geometric past. This process could occur also after the physical death.

There is an objection against this view: the me of my geometric past cannot possess much volition because this would lead to paradoxical sudden changes of the world geometrically now. Paradoxes are avoided if the volition of the me of the geometric past affects the universe only in a finite interval of geometric time so that the me of the geometric now does not experience these effects. The nondeterminism of Kähler action indeed suggests that the net effect of free will cancels in the long run. Paradoxes are thus avoided if there is some minimum distance between the successive p-adic phase transition fronts, presumably given by an appropriate p-adic time scale (of the order of the duration of the life cycle or longer). This would conform with the second law in generalized form stating that volitional effects cancel in time scales longer than the p-adic time scale. These p-adic phase transition fronts should be common to entire biosphere at the same level of self hierarchy.

The fractality of consciousness suggests that the anatomy of the quantum jump reflects what happens during the life cycle. A quantum superposition of potentialities is generated and followed by gradual analysis. This has the decay of 3-D physical body as its physical correlate. The time scale for this kind of cycle corresponds to the lifetime of bound state at relevant p-adic length scale and the process repeats: each lifecycle is effectively single quantum jump in an appropriate time scale.

Thus Grand Scenario suggests that the tyranny of time might be an illusion created by the time localization for the contents of sensory experience, the local arrow of psycholocal time and the natural self-centeredness of conscious beings. There would be no real death: or stated otherwise, we die all the time. Even more: that this life was perhaps not a success story is not a too big tragedy: there is great number of lives in store. Various reincarnations of me in my geometric past could subjectively coexist with me and experience a course of life slightly different from mine. My decisions affect also their life since past is changed in each quantum jump and also their decisions affect me. This endless living again is not just boring repetition: p-adic evolution implies that the new version of my life is in statistical sense (one can indeed use this phrase here!) better than the previous ones. In accordance with the quantum-classical correspondence principle and fractal cosmology of consciousness, this is nothing but recreation of the personal cosmology again and again, making possible gradual personal growth.

## 5 Time delays of consciousness and quantum jumps between histories

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 [19, 22] and described by Penrose in his book [24]. It is also possible to explain the causal anomalies revealed by the experiments of Radin and Bierman [32, 33, 34]. TGD predicts "tribar effect" as a general signature for the quantum jump between quantum histories concept.

### 5.1 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 [18] discussed in [H3] 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 [18]: this should lead to paralysis if standard wisdom about brain functioning would hold true!

## 5.2 Experiments related to the active role of consciousness

The first class of experiments [19] is related to the active role of consciousness. For example, the human subject flexes his finger at free will. What happens is that neurophysiological processes (changes in EEG) start about one second before the conscious decision to flex the finger is made. Decision seems to be followed by the action rather than the 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.

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 finger flexing corresponds to the moment, when subject person experiences finger flexing occurs.
2. The new quantum history differs in detectable manner from the old quantum history already before the moment of finger flexing since otherwise the new history would contain an instantaneous and discontinuous jump from non-flexed finger to flexed finger configuration, which is not allowed by field equations.  $\Delta T$  of order one second seems to be the relevant time scale. It is important to notice that the difference is at the level of classical physics rather than, say, in the form of synchronous neural firing which might involve quantum jumps of lower level selves: in TGD framework EEG activity is indeed classical phenomenon.
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 finger flexing with respect to geometric time. With respect to the subjective time the cause of the finger flexing is the decision of the subject person.
4. This explanation is based on the hypothesis that volitional actions are top-down actions starting from the level of the entire body. A less radical variant of this argument is that the time associated with the conscious decision to flex the finger corresponds to a discontinuous configurational change at the level of brain: the jump from non-flexed to flexed configuration would occur at the representational level and induce continuous flexing of finger. This does not however change the core of the argument.

### 5.3 Experiments related to the passive role of consciousness

Libet's experiments [22] 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 [H4].

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 there 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 sensory organs so that the sensation of touch requires back-projection from cortex to the skin. If the formation of back projection would takes about .5 seconds the observations can be understood. Genuine sensory stimulus creates cortical mental image almost immediately: this mental image is then communicated to magnetic body (time like entanglement).

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.

According to the TGD based vision sensory mental images are at the level of sensory organs and brain constructs symbolic representations about them using intensive back-projections to the sensory organs. These representations give rise to a decomposition of the perceptive field to standardized sensory mental images. The most effective manner to achieve back-projection is by using negative energy signals propagating backwards in geometric time just like in the case of intentional action. Accepting this framework one can at least make questions.

i) Could the stimulation of the cortex induce a negative energy back-projection signal to the skin representing a stimulus effectively interfering to zero with the real stimulus? That the skin stimulus is perceived consciously for  $T < .25$  seconds means that the compensating back projection is sent only if cortex has received information about skin stimulation. One can imagine that it takes .25 seconds to form a symbolic representation about the sensory mental images at sensory organ. Why the back-projection would compensate the skin stimulus?

It is known that brain acts like a highly selective gardener applying strong inhibition to certain sensory stimuli and strong excitation to others in order to build percepts. If this principle applies also in time domain - as it should if the paradigm of 4-D brain is accepted- the elimination of the sensory stimulus could be seen as a tendency to build sensory percepts which are sharply localized in time. A precise localization in time is indeed important in the case of sensory percepts.

Second explanation would be based on compensating back-projection. Everyone who has been swimming in windy sea, feels the waves for a long

time after coming to the shore. This sensation would correspond to back-projection in TGD framework but it is not clear to me whether this back-projection tends to compensate the actual sensation in order to achieve metabolic economy.

ii) Could it be that the skin stimulus is actually consciously perceived but that this experience is not remembered? In TGD framework the memory about skin stimulus would be realized as a skin stimulus still continuing in the geometric past. If the cortical stimulation for some reason modifies the geometric past by destroying the skin stimulus using back-projection, there would be no memory about the skin stimulus.

*1. Two options for the communications to the magnetic canvas*

Consider now possible constraints from Libet's experiments on the model of sensory representations based on the notion of magnetic canvas. MEs induce magnetic quantum phase transitions via the classical magnetic field associated with them and oscillating with a multiple of the cyclotron frequency. There are two possibilities.

1) The classical signal is thought to propagate along an existing em ME to the magnetic canvas and induces the magnetic quantum phase transition.

2) MEs behave like topological field quanta. A passive  $Z^0$  ME is replaced with a an active em ME in single quantum jump so that the signal propagates to the magnetic canvas effectively instantaneously.

*2. Various time lapses involved*

Let us first analyze various time lapses which can be involved in the process leading from the sensory stimulus to the sensory experience.

1. The propagation of the classical signal along ME to the magnetic sensory canvas takes some time. This gives upper bound for the possible sizes  $L$  of MEs. The lapse is however for  $T_{cl} \sim L/c = 1/f$ , which is about .1 seconds for earth-sized MEs and of same order as the time lapse  $T_b \simeq .01$  seconds due to the conduction of the nerve pulses from skin to somatosensory cortex.
2. The time  $T_m$  for the magnetic quantum phase transition to occur should be  $T_m \sim 1/\Gamma$ , where  $\Gamma$  is the rate  $\Gamma$  for cyclotron transitions for ions in the harmonic perturbation defined by the classical magnetic field  $B$  associated with ME. If the magnetic quantum transitions occur incoherently, Golden Rule implies that the rate  $\Gamma$  should be of order

$$\Gamma \sim N \left( \frac{B^2}{B_e} \right)^2 f_c ,$$

where  $B$  is the amplitude of the oscillating magnetic field associated with ME,  $B_e$  is Earth's magnetic field,  $f_c$  is the corresponding cyclotron frequency, and  $N$  is the number of ions participating in the transition.

If  $T_m$  indeed represents a lapse of conscious experience then the magnetic field associated with the radial ME inducing the magnetic quantum phase transition should be very strong as compared with the typical intensities in MEG unless  $N$  is large. The relative intensity of the fluctuations of Earth's magnetic field is about  $\Delta B/B_e \sim 10^{-8}$  and gives an estimate for the intensity of  $B$ . The lower bound for the number of ions participating to the quantum phase transition is  $N = 10^{16}$ . Since the magnetic flux tube has thickness of order cell size, and since there are not much more than about  $10^2$  ions per cellular volume, the required length of the magnetic flux tube participating in the quantum transition would be longer than  $10^8$  meters and is definitely too long.

Quantum coherence can however come in rescue here. If the magnetic transitions occur coherently, the rate is given by

$$\Gamma \sim N^2 \left(\frac{B}{B_e}\right)^2 f_c ,$$

where  $N$  is the number of the ions participating in the transitions. For  $N > B_e/B$  ( $\sim 10^8$  for  $B \sim 10^{-8}B_e$ ) the rate is high enough if the length of the magnetic flux tube participating in which quantum phase transition occurs longer than  $10^2$  meters. Since the intensity of the magnetic field varies extremely slowly along the magnetic flux tube in the proposed model, the number of the ions participating the transition could indeed be large enough and  $T_m$  would become an unimportant factor.

3. The total lapse of time is  $T = T_b + T_{cl} + T_m + T_p$ , where  $T_b \sim .01$  seconds is the time for the signal to propagate to the somatosensory area and  $T_p$  is the time used by cortex to estimate the position of the sensory stimulus and activate the MEs taking care of the sensory projection to the magnetic canvas. Since the coding of the position of skin is topographic, there is no need to compute the distance and orientation of the stimulus and one has  $T_p$  is minimal. This gives  $T = T_b + T_{cl} + T_m + T_p$  for the classical option 1) and  $T = T_b + T_m + T_p$  for the quantum option 2).

### 3. Constraints from Libet's experiments

It is interesting to look what Libet's experiments mean for various options about what precedes the magnetic quantum phase transition giving rise to the sensory experience. The basic observation is that the classical signal propagation time along ME, which is .1 seconds for magnetic flux tube at distance of order Earth circumference, is much shorter than the time .5 seconds between the sensory stimulus and conscious experience. Thus it does not strong constraints on the model based on option 1).

1. If one assumes that the formation of the sensory representations involves the propagation of a classical signals along MEs (option 1)), and that

the sensory representation of the skin is at distance of, say, one fourth of Earth's radius corresponding to the frequency  $f = 10$  Hz, the lapse is about  $T \simeq T_b + T_{cl} + T_m + T_p = .1 + T_m$  seconds. This allows  $T_m + T_p \simeq .4$  seconds. For  $T_m \ll T_b$   $T_p \simeq .4$  seconds is allowed. In classical case there are however bounds on the distance of the magnetic canvas, five Earth circumferences is the upper bound.

2. Second option is that the process does not involve classical signalling in the proposed sense so that the distance of magnetic canvas does not matter at all. ME behaves as a single particle and is transformed from passive  $Z^0$  ME to active em ME in single quantum jump. Suppose the arrival of the neuronal signal induced by the electrical stimulation of the skin to the somatosensory area induces this kind of quantum jump, which becomes thus capable of inducing magnetic quantum phase transition. If this is the case, then the sensory representation of the stimulus could result after  $T \sim T_b + T_m + T_p$  after the arrival of the neural signal to the cortex. If  $T_m$  is negligible one has  $T \simeq T_p \simeq .5$  seconds. The fact that the stimulation of cortex by .5 seconds is needed to produce artificially the sensory stimulus suggests that  $T_m$  is indeed negligible.
3. The third option is that there is a ME associated with the entire sensory pathway fused with the ME associated with the sensory projection to the magnetic canvas and that already the sensory stimulus at the skin initiates the magnetic quantum phase transition. In this case one has  $T = T_m \simeq .5$  seconds.

#### 5.4 The experiment of Radin and Bierman as evidence for quantum jump between quantum histories concept

The experiments of Radin [34] and the later experiments by Radin and Bierman [32, 33] 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 [21] suggested a modification of Radin-Bierman experiment [32, 33, 34] providing a test for Stapp's and Sarfatti's theories of consciousness [28, 29]. 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 [29]) 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 [21] 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 subexperiences 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 sub-conscious mind. The phenomenon of blind sight and related phenomena [23] 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  $\Delta t$  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 nonexisting 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 [24] 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.

## References

### Online books about TGD

- [1] M. Pitkänen (2006), *Topological Geometroynamics: Overview*.  
<http://www.helsinki.fi/~matpitka/tgdview/tgdview.html>.
- [2] M. Pitkänen (2006), *Quantum Physics as Infinite-Dimensional Geometry*.  
<http://www.helsinki.fi/~matpitka/tgdgeom/tgdgeom.html>.

- [3] M. Pitkänen (2006), *Physics in Many-Sheeted Space-Time*.  
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html>.
- [4] M. Pitkänen (2006), *Quantum TGD*.  
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html>.
- [5] M. Pitkänen (2006), *TGD as a Generalized Number Theory*.  
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html>.
- [6] M. Pitkänen (2006), *p-Adic length Scale Hypothesis and Dark Matter Hierarchy*.  
<http://www.helsinki.fi/~matpitka/paddark/paddark.html>.
- [7] M. Pitkänen (2006), *TGD and Fringe Physics*.  
<http://www.helsinki.fi/~matpitka/freenergy/freenergy.html>.

## Online books about TGD inspired theory of consciousness and quantum biology

- [8] M. Pitkänen (2006), *Bio-Systems as Self-Organizing Quantum Systems*.  
<http://www.helsinki.fi/~matpitka/bioselforg/bioselforg.html>.
- [9] M. Pitkänen (2006), *Quantum Hardware of Living Matter*.  
<http://www.helsinki.fi/~matpitka/bioware/bioware.html>.
- [10] M. Pitkänen (2006), *TGD Inspired Theory of Consciousness*.  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html>.
- [11] M. Pitkänen (2006), *Mathematical Aspects of Consciousness Theory*.  
<http://www.helsinki.fi/~matpitka/genememe/genememe.html>.
- [12] M. Pitkänen (2006), *TGD and EEG*.  
<http://www.helsinki.fi/~matpitka/tgdeeg/tgdeeg.html>.
- [13] M. Pitkänen (2006), *Bio-Systems as Conscious Holograms*.  
<http://www.helsinki.fi/~matpitka/hologram/hologram.html>.
- [14] M. Pitkänen (2006), *Magnetospheric Consciousness*.  
<http://www.helsinki.fi/~matpitka/magnconsc/magnconsc.html>.
- [15] M. Pitkänen (2006), *Mathematical Aspects of Consciousness Theory*.  
<http://www.helsinki.fi/~matpitka/magnconsc/mathconsc.html>.

## References to the chapters of books

- [C10] The chapter *Does TGD Predict the Spectrum of Planck Constants?* of [4].  
<http://www.helsinki.fi/~matpitka/tgdquant/tgdquant.html#Planck>.
- [D1] The chapter *Basic Extremals of Kähler Action* of [3].  
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#class>.
- [D7] The chapter *Macroscopic Quantum Phenomena and  $CP_2$  Geometry* of [3].  
<http://www.helsinki.fi/~matpitka/tgdclass/tgdclass.html#super>.
- [E10] The chapter *DNA as Topological Quantum Computer* of [5].  
<http://www.helsinki.fi/~matpitka/tgdnumber/tgdnumber.html#dnatqc>.
- [G2] The chapter *The Notion of Free Energy and Many-Sheeted Space-Time Concept* of [7].  
<http://www.helsinki.fi/~matpitka/freenergy/freenergy.html#freenergy>.
- [H1] The chapter *Matter, Mind, Quantum* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#conscic>.
- [H2] The chapter *Negentropy Maximization Principle* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#nmpc>.
- [H3] The chapter *Self and Binding* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#selfbindc>.
- [H4] The chapter *Quantum Model for Sensory Representations* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#expc>.
- [H5] The chapter *Time and Consciousness* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#timesc>.
- [H6] The chapter *Quantum Model of Memory* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#memoryc>.
- [H8] The chapter *p-Adic Physics as Physics of Cognition and Intention* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#cognic>.
- [H9] The chapter *Quantum Model for Paranormal Phenomena* of [10].  
<http://www.helsinki.fi/~matpitka/tgdconsc/tgdconsc.html#parac>.
- [I3] The chapter *Biological Realization of Self Hierarchy* of [8].  
<http://www.helsinki.fi/~matpitka/bioselforg/bioselforg.html#bioselfc>.
- [I4] The chapter *Quantum Control and Coordination in Bio-systems: Part I* of [8].  
<http://www.helsinki.fi/~matpitka/bioselforg/bioselforg.html#qcococI>.

- [I5] The chapter *Quantum Control and Coordination in Bio-Systems: Part II* of [8].  
<http://www.helsinki.fi/~matpitka/bioselforg/bioselforg.html#qcococII>.
- [J1] The chapter *Bio-Systems as Super-Conductors: part I* of [9].  
<http://www.helsinki.fi/~matpitka/bioware/bioware.html#superc1>.
- [J2] The chapter *Bio-Systems as Super-Conductors: part II* of [9].  
<http://www.helsinki.fi/~matpitka/bioware/bioware.html#superc2>.
- [J3] The chapter *Bio-Systems as Super-Conductors: part III* of [9].  
<http://www.helsinki.fi/~matpitka/bioware/bioware.html#superc3>
- [J4] The chapter *Quantum Antenna Hypothesis* of [9].  
<http://www.helsinki.fi/~matpitka/bioware/bioware.html#tubuc>.
- [J5] The chapter *Wormhole Magnetic Fields* of [9].  
<http://www.helsinki.fi/~matpitka/bioware/bioware.html#wormc>.
- [K1] The chapter *Time, Spacetime and Consciousness* of [13].  
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#time>.
- [K2] The chapter *Macro-Temporal Quantum Coherence and Spin Glass Degeneracy* of [13].  
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#macro>.
- [K3] The chapter *General Theory of Qualia* of [13].  
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#qualia>.
- [K5] The chapter *Homeopathy in Many-Sheeted Space-Time* of [13].  
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#homeoc>.
- [K6] The chapter *Macroscopic Quantum Coherence and Quantum Metabolism as Different Sides of the Same Coin* of [13].  
<http://www.helsinki.fi/~matpitka/hologram/hologram.html#metab>.
- [L1] The chapter *Genes and Memes* of [11].  
<http://www.helsinki.fi/~matpitka/genememe/genememe.html#genememec>.
- [N1] The chapter *Magnetospheric Sensory Representations* of [14].  
<http://www.helsinki.fi/~matpitka/magnconsc/magnconsc.html#srepres>.
- [N2] The chapter *Crop Circles and Life at Parallel Space-Time Sheets* of [14].  
<http://www.helsinki.fi/~matpitka/magnconsc/magnconsc.html#crop1>.
- [N3] The chapter *Crop Circles and Life at Parallel Space-Time Sheets* of [14].  
<http://www.helsinki.fi/~matpitka/magnconsc/magnconsc.html#crop2>.

## Physics related references

- [16] Sentman, D., D. (1985) *Schumann Resonances*, in CRC Handbook of Atmospheric Electrodynamics, (Hans Volland, ed.), CRC Press, Boca Raton. <http://sprite.gi.alaska.edu/schuchar.htm>.

## Biology

- [17] G. Pollack (200?), *Cells, Gels and the Engines of Life*, Ebner and Sons. <http://www.cellsandgels.com/> .

## Brain science, consciousness

- [18] R. Cytowich (1995), Synesthesia: Phenomenology and Physiology, *Psyche* 2(10), July 1995. <http://psyche.cs.monash.edu.au/v2/psyche-2-10-cytowic.html>.
- [19] L. Deeke, B. Götzinger and H. H. Kornhuber (1976), *Voluntary finger movements in man: cerebral potentials and theory*, *Biol. Cybernetics*, 23, 99.
- [20] T. van Flandern (1998), *Phys. Lett. A*, vol. 250, no 1-3 p. 1-11.
- [21] Stan Klein, *A simple suggestion for testing Stapp's theory* (29. October 1998), <http://listserv.arizona.edu/lsv/www/quantum-mind.html>.
- [22] B. Libet, E. W. Wright Jr., B. Feinstein, and D. K. Pearl (1979), *Subjective referral of the timing for a conscious sensory experience* *Brain*, 102, 193-224.
- [23] *New Scientist* (1998), *The unconscious mind*, Vol 159, 2150, Sept. 5
- [24] R. Penrose (1989) *The Emperor's New Mind*, Oxford University Press.
- [25] M. Persinger (1999), *The tectonic strain theory as an explanation for UFO phenomena* <http://www.laurentian.ca/www/neurosci/tectonicedit.htm>.
- [26] M. Persinger (1995), *On the possibility of directly accessing every human brain by electromagnetic induction of fundamental algorithms*, *Percept. Mot. Skills*, 80(3 Pt 1), 791-9.
- [27] M. Persinger (1987) *Neuropsychological Bases of God Beliefs*, Praeger Publishers.
- [28] H.P. Stapp (1993), *Mind, Matter and Quantum Mechanics*, Springer-Verlag, Berlin, New York. p. 130.  
See also <http://listserv.arizona.edu/lsv/www/quantum-mind.html>

- [29] <http://www.hia.com/pcr>.  
See also <http://listserv.arizona.edu/lsv/www/quantum-mind.html>
- [30] J. P. Miller (1996), *Brain Waves Deciphered*, article about the work of Wehr and Laurent in Nature, vol 384 (14 November).
- [31] S. Klein (2002), *Libet's Research on Timing of Conscious Intention to Act: A Commentary* of Stanley Klein, Consciousness and Cognition 11, 273-279.  
[http://cornea.berkeley.edu/pubs/ccog\\_2002\\_0580-Klein-Commentary.pdf](http://cornea.berkeley.edu/pubs/ccog_2002_0580-Klein-Commentary.pdf).

## Remote mental interactions, etc...

- [32] D. J. Bierman and D. I. Radin (1997), *Anomalous Anticipatory Response on Randomized Future Conditions*, Perceptual and Motor Skills, 84, pp. 689-690.
- [33] D.J Bierman and D. I. Radin (1998), *Anomalous unconscious emotional responses: Evidence for a reversal of the arrow of time*.  
<http://www-psy.uva.nl/resedu/pn/PUBS/BIERMAN/1998/tucson/tucson3.html>.
- [34] D. I. Radin (1997), *Unconscious perception of future emotions: An experiment in presentiment*. Journal of Scientific Explorlation, 11 (2), 163-180.

## References related to physics anomalies

- [35] Yu. V. Nachalov (1999) *Theoretical basis of experimental phenomena*  
<http://www.amasci.com/freenrg/tors/>.
- [36] Yu. V. Nachalov and A.N. Sokolov (1999) *Experimental investigation of new long-range interactions*  
<http://www.amasci.com/freenrg/tors/>.
- [37] Akimov A.E., Kovalchuk G.U., Medvedev V.G., Oleinik V.K., Pugach A.F. "Predvaritelnyye rezultaty astronomicheskikh nabludenii po metodike N.A.Kozyreva.", Kiev, 1992, GAO AN Ukrainy, preprint # GAO-92-5R. (russian) ("Preliminary results of astronomical observations using N.A.Kozyrev's method.")
- [38] N.A. Kozyrev (1991) "Izbrannyye trudy.", Leningrad State University, 448 p. (russian) ("Selected works.")

- [39] Lavrentiev M.M., Yeganova I.A., Medvedev V.G., Oleinik V.K., Fominykh S.F. "O skanirovanii zvyezdnoho neba datchikom Kozyreva." Doklady Akademii Nauk SSSR, 1992, v.323, # 4. (russian) ("On the scanning of the star sky with Kozyrev's detector.")
- [40] D. Whitehouse (2002), *Beads of doubt*, BBC News, [http://news.bbc.co.uk/1/hi/english/sci/tech/newsid\\_2135000/2135779.stm](http://news.bbc.co.uk/1/hi/english/sci/tech/newsid_2135000/2135779.stm).
- [41] V. Poponin (1996), *DNA PHANTOM EFFECT: Direct Measurement of a New Field in the Vacuum Substructure*, <http://www.webcom/~hrtmath/IHM/ResearchPapers/DNAPhantom/DNAPhantom.html>
- [42] V. V. Roshchin and S. M. Godin, *An Experimental Investigation of the Physical Effects in a Dynamic Magnetic System*, New Energy Technologies Issue #1 July-August 2001.