

# Wormhole Magnetic Fields

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## Contents

<b>1</b>	<b>Introduction</b>	<b>4</b>
<b>2</b>	<b>Basic Conceptual Framework</b>	<b>6</b>
2.1	Basic Concepts . . . . .	6
2.1.1	$CP_2$ type vacuum extremals . . . . .	6
2.1.2	Wormhole contacts as parton pairs . . . . .	6
2.1.3	$\#_B$ contacts as bound parton pairs . . . . .	7
2.1.4	Wormhole contacts as bosons and their super partners . . . . .	8
2.1.5	Topological condensation and evaporation . . . . .	8
2.2	Gauge Charges And Gauge Fluxes . . . . .	9
2.2.1	How to define the notion of gauge charge? . . . . .	9
2.2.2	In what sense could $\#$ contacts feed gauge fluxes? . . . . .	10
2.2.3	Are the gauge fluxes through $\#$ and $\#_B$ contacts quantized? . . . . .	11
2.2.4	Hierarchy of gauge and gravitational interactions . . . . .	11
2.3	The Relationship Between Inertial And Gravitational Masses . . . . .	11
2.3.1	ZEO and non-conservation of Poincare charges in Poincare invariant theory of gravitation . . . . .	12
2.3.2	Equivalence Principle at quantum level . . . . .	12
2.3.3	Equivalence Principle at classical level . . . . .	13
2.3.4	Gravitational mass is necessarily accompanied by non-vanishing gauge charges . . . . .	13
2.4	Can One Regard $\#$ <i>Resp.</i> $\#_B$ Contacts As Particles <i>Resp.</i> String Like Objects? . . . . .	14
2.4.1	$\#$ contacts as particles and $\#_B$ contacts as string like objects? . . . . .	14
2.4.2	Could $\#$ and $\#_B$ contacts form Bose-Einstein condensates? . . . . .	15
2.5	TGD Based Description Of External Fields . . . . .	15
2.5.1	Induction mechanism . . . . .	16
2.5.2	Penetration of magnetic fluxes via $\#$ contacts . . . . .	16

2.5.3	Penetration of electric gauge fluxes via $\#$ contacts . . . . .	16
2.5.4	Penetration via $\#_B$ contacts . . . . .	17
2.6	Number Theoretical Considerations . . . . .	18
2.6.1	How to define the notion of elementary particle? . . . . .	18
2.6.2	What effective p-adic topology really means? . . . . .	18
2.6.3	Do infinite primes code for q-adic effective space-time topologies? . . . . .	19
2.6.4	Under what conditions space-time sheets can be connected by $\#_B$ contact? . . . . .	20
<b>3</b>	<b>Model For Topologically Quantized Magnetic Field</b>	<b>21</b>
3.1	Topological Field Quantization . . . . .	21
3.2	Mind Like Space-Time Sheets . . . . .	22
3.3	Do Mind-Like Space-Time Sheets Perform Simple Mimicry? . . . . .	24
3.4	Model For Wormhole Flux Tube As A Hollow Cylinder . . . . .	24
3.5	Wormhole Flux Tubes Need Not Be Closed In Ordinary Sense . . . . .	25
3.6	Wormhole Flux Tubes Form A Macroscopic Quantum System . . . . .	25
3.7	The Interaction Of Coherent Light With Wormhole Flux Tubes . . . . .	25
3.8	Quantum Antenna Hypothesis And Wormholes . . . . .	26
3.9	Phantom DNA Effect, Comorosan Effect, DNA As A Conductor, ORMEs: Four Peculiar Effects With A Common Explanation . . . . .	26
<b>4</b>	<b>Comorosan Effect, Phantom DNA Effect And Homeopathy</b>	<b>26</b>
4.1	Comorosan Effect . . . . .	26
4.1.1	The effect . . . . .	26
4.1.2	Model for the interaction of laser light with organic molecule . . . . .	27
4.1.3	The explanation for Comorosan formula . . . . .	29
4.1.4	What is the origin of the 5 second time scale? . . . . .	30
4.2	Phantom DNA Effect . . . . .	30
4.2.1	Is the mechanism explaining Comorosan effect behind phantom DNA effect? . . . . .	31
4.2.2	Other explanations . . . . .	31
4.3	Mind-Like Space-Time Sheets, Mimicry And Homeopathy . . . . .	32
4.4	Clustering of RNA polymerase molecules and Comorosan effect . . . . .	33
4.4.1	TGD view about the findings . . . . .	33
4.4.2	About Comorosan effect and clustering of RNA II polymerase proteins . . . . .	35
<b>5</b>	<b>Subcellular Control And Wormhole Flux Tubes</b>	<b>37</b>
5.1	Intracellular Bio-Control And Memory . . . . .	37
5.2	Coding Of Genetic Information To Topologically Quantized Fields? . . . . .	38
5.3	Are Magnetic And Wormhole Magnetic Fields Involved With The Control Of Gene Expression? . . . . .	38
5.4	Wormhole Flux Tubes As Templates Of Bio-Structures . . . . .	39
<b>6</b>	<b>TGD Inspired Models For Psychokinesis</b>	<b>39</b>
6.1	Wormhole Magnetic Fields And Psychokinesis . . . . .	40
6.1.1	PK as a special case of voluntary action . . . . .	40
6.1.2	Quantum entanglement and PK . . . . .	40
6.1.3	Bio-systems and classical $Z^0$ fields . . . . .	40
6.1.4	Magnetic levitation as a basic mechanism of PK . . . . .	41
6.1.5	Topological field quantization could make possible precise quantum control of magnetic fields . . . . .	41
6.1.6	Order of magnitude estimates . . . . .	42
6.2	Alternative Models Of Psychokinesis . . . . .	43
6.3	Experimental Tests . . . . .	44

### Abstract

The first version of this chapter was written for almost two decades ago and some interpretations have changed since then. It was argued that two purely TGD based concepts: topological field quantization and wormhole BE condensate are fundamental for the understanding of biosystems. There is not reason to modify this claim. The ideas about the physical interpretation of wormhole contacts have however developed since then dramatically: in the recent formulation of the theory wormhole contacts define basic building bricks of elementary particles. Hierarchy of Planck constants assigned with dark matter is second new notion and this might allow to see wormhole BE-condensates as BE-condensates of dark variants of ordinary particles.

#### 1. Basic concepts

Quantum classical correspondence suggests that gauge charges and p-adic coupling constant should have space-time counterparts. The first problem is to define precisely the concepts like classical gauge charge, gauge flux, topological condensation and evaporation. The crucial ingredients in the model are so called  $CP_2$  type extremals. The realization that  $\#$  contacts (topological sum contacts and  $\#_B$  contacts (join along boundaries bonds) are accompanied by causal horizons which carry quantum numbers and allow identification as partons leads to a solution of this problem.

The partons associated with topologically condensed  $CP_2$  type extremals carry elementary particle vacuum numbers whereas the parton pairs associated with  $\#$  contacts connecting two space-time sheets with Minkowskian signature of induced metric define parton pairs. These parton pairs do not correspond to ordinary elementary particles. Gauge fluxes through  $\#$  contacts can be identified as gauge charges of the partons. Gauge fluxes between space-time sheets can be transferred through  $\#$  and  $\#_B$  contacts concentrated near the boundaries of the smaller space-time sheet.

It has become clear that the notion of  $\#_B$  contact might require a modification. There are reasons to argue that boundary conditions do not allow space-time surfaces to have boundaries but are replaced by 2-fold coverings obtained by gluing two space-time sheets along their boundaries together. The 3-D light-like orbits of wormhole contacts at which Minkowskian signature of the induced metric changes to Euclidian, have replaced boundaries and  $\#_B$  contacts could be either magnetic flux tubes with Minkowskian metric or Euclidian flux tube like regions.

#### 2. Model for topologically quantized magnetic fields

Topological field quantization replaces classical magnetic fields with bundles of flux tubes parallel to the field lines; flux tubes are cylindrical 3-surfaces with outer boundary. In particular, “wormhole magnetic fields” having charged wormholes situated at the boundaries of the flux tubes as their sources, are possible and are vacuum configurations in the sense that they do not contain ordinary matter at all. Since wormholes are very light particles, they can suffer BE condensation, and the resulting structure is macroscopic quantum system.

The recent view about particles suggests that wormhole BE-condensates are BE-condensates of particle with non-standard and large value of Planck constant. Magnetic fluxes and their braiding play key role in the TGD inspired model of topological quantum computation in living manner. This suggests that wormhole magnetic fields and more general structures of the same kind could realize quantum physicist’s version about the computer scientist’s dream about universe consisting of Turing machines emulating each other.

#### 3. Models for Comorosan effect, phantom DNA effect, and homeopathy

It is shown that the concept of wormhole magnetic fields suggest a model of *Comorosan effect* and *phantom DNA effect*. Homeopathy could be explained in terms of the mind-like space-time sheets mimicking the properties of the drug and left to the solution in the repeated dilution of the drug. Wormhole magnetic fields provide a quantum mechanism of control from distance, say of the control of the behavior of cell organelles by cell nucleus as well as a model for the memory of bio-system in terms of integer valued winding numbers identifiable as quantized momenta of wormhole supra currents. Wormhole magnetic fields can also represent defects of electron and neutrino super conductors and serve as a templates for the topological condensation of ordinary matter. The fact that wormhole flux tubes are *hollow* cylinders, is in nice accordance with this idea (microtubules, axonal membranes, etc. are hollow cylinders).

#### 4. TGD inspired model for psychokinesis

A model of psychokinesis (PK) based on the concept of wormhole magnetic field is proposed. The basic philosophy is that PK is not just some isolated exotic phenomenon but only a special case of the voluntary control of bodily motions, which we all routinely perform. The only difference is that the range of voluntary control extends over the boundaries of the body in case of PK. The conclusion is that PK phenomena must involve classical long range fields, which give for bio-systems spatial extension larger than what is visible (that is hands with which to grasp on external object!). According to TGD inspired theory of consciousness, cell, and even DNA can be conscious, and perform choices. Thus the model should also provide understanding about small scale bio-control such as the (possibly voluntary!) control of the motion of cell organelles performed by cell nucleus. There is also alternative approach to the understanding of psychokinesis based on the possibility of creation of space-time sheets having negative time orientation and negative classical energy density and one could consider the possibility that poltergeist effects could involve this mechanism. Many-sheeted space-time concept makes possible also psychokinesis based on levitation: what is needed that subsystem is able to topologically condense to a sufficiently large space-time sheet carrying very weak gravitational fields.

## 1 Introduction

Topological field quantization has turned out to be fundamental for the understanding of quantum TGD and TGD inspired theory of consciousness. What makes topological field quantization so important is that it provides very precise classical representation for the quantum aspects of the theory. Even virtual particles have geometric counterparts. In TGD the sign of the classical energy correlates with the time orientation of the space-time sheet and this makes possible pairs of space-time sheets of finite duration having vanishing total energy. This suggests an astonishingly simple mechanism for the formation of cognitive representations: direct mimicry in which classical fields in some region of the material space-time sheet are realized at the two mind-like space-time sheets of opposite time orientation! This realization would make physicist's universe analogous to the computer scientist's universe filled with computers emulating each other. Concerning the understanding of how intelligent consciousness is realized, the implications would be highly nontrivial.

The fact that em fields oscillating with multiples of the cyclotron frequencies of various charged particles in Earth's magnetic fields have effects on living matter [J2] could indeed mean that biomatter mimics Earth's magnetic field by forming double sheeted structures, wormhole magnetic fields, with magnetic field strength equal to that of Earth's magnetic field. This observation could serve as a good motivation for the modelling of wormhole magnetic fields. This was not the original motivation for studying wormhole magnetic fields. Rather, it was the modelling of homeopathy in terms mind-like space-time sheets, which led to the discovery of the astonishing possibility of a direct mimicry performed by mind-like space-time sheets. Note that also more abstract cognitive representations are possible. In particular, various oscillation frequencies of material space-time sheets could be transferred to mind-like space-time sheets and the counterparts of FM and AM modulation would provide obvious cognitive representations.

Topological field quantization originates from the fact that given classical gauge field configuration does not allow global representation as an induced gauge field but space-time splits into separate regions, topological field quanta. Typically, magnetic field reduces to a bundle of disjoint *flux tubes* flowing along field lines of classical field, which in TGD context are cylindrical regions of 3-space with outer boundaries. There is no doubt about the fundamental importance of topological field quanta for biosystems if TGD is correct and the natural working hypothesis is that topologically quantized classical gauge field configurations belong to the basic tools of biocontrol and that the vacuum quantum numbers characterizing topological field quanta (for the definition of vacuum quantum numbers see the Appendix) carry bio-information.

It has also become clear, that the closely related concepts of *many-sheeted space-time* and *charged wormhole* play crucial role in biosystems. Wormholes feed gauge fluxes from a smaller sheet of 3-space to a larger one and are located near the boundary of the smaller 3-space sheet and have size of order  $CP_2$  length of order  $10^4$  Planck lengths as do also ordinary elementary particles. Not only electromagnetic but also  $Z^0$  wormholes are possible in TGD since long range classical  $Z^0$  fields are unavoidable in TGD context. Wormhole throat can have also magnetic

charge. Furthermore, the topology of the wormhole throat, being characterized by the genus of the 2-surface in question, gives rise to a degeneracy analogous to the family replication of elementary fermions.

Wormhole concept leads naturally to the concept of *wormhole flux tube*, which by assumption contains no ordinary matter inside it and is forced by Maxwell equations to be a *hollow cylinder*. Maxwell's equations require rotating charge carrier densities with opposite total charges on the inner and outer boundaries of this cylinder. Since ordinary charges are excluded, the only possibility is that these charge carriers are charged wormholes. Since the wormhole behaves like a gauge charge  $\pm Q$  on the two space-time sheets respectively, there is return flux on the second space-time sheet. Wormhole flux tubes need not be closed unlike ordinary flux tubes: at the end point magnetic flux just flows from "upper" space-time sheet to the "lower" space-time sheet via magnetic wormhole behaving as magnetic charge  $\pm Q_m$  on the two space-time sheets respectively. Charged wormhole flux tubes can form arbitrary complicated net like structures. Since wormholes form *BE condensate* and behave as super conductor, the classical field is transformed in TGD context to a macroscopic quantum system, *wormhole magnetic field*. It has become clear that electronic and neutrino superconductivity might play fundamental role in biosystems: it might be even possible to identify the quantum correlates of sensory qualia as coherent photons and gravitons, wormhole BE condensate and BE condensates of electronic and neutrino Cooper pairs. What is important is that wormhole magnetic fields seem to provide a topological representation for the defects of fermionic super conductors.

Quantum antenna hypothesis states that the light-like vacuum currents associated with microtubules, and possibly also other linear structures, serve as sources of quantum coherent photon fields [K19], in particular of bio-photons. The phenomenon of sonoluminescence has an explanation in terms of light-like vacuum currents underlying the quantum antenna hypothesis and that microtubular diameter provides a natural intrinsic length scale of hydrodynamics of water. One of the many challenges is to understand how wormholes and coherent photons interact. In this chapter a model for this interaction is proposed. The model leads to possible explanations of *Comorosan effect* [I6, I2] and *phantom DNA effect* [I4, I8]. Also the effect of homeopathy could reduce to that of mind-like space-time sheets associated with the drug if these mind-like space-time sheets mimic directly the classical gauge field structure of the drug.

The first version of this chapter was written for almost two decades ago and some interpretations have changed since then. It was argued that two purely TGD based concepts: topological field quantization and wormhole BE condensate are fundamental for the understanding of biosystems. There is no reason to modify this claim. The ideas about the physical interpretation of wormhole contacts have however developed since then dramatically: in the recent formulation of the theory wormhole contacts define basic building bricks of elementary particles. Hierarchy of Planck constants assigned with dark matter is second new notion and this might allow to see wormhole BE-condensates as BE-condensates of dark variants of ordinary particles.

The concept of wormhole magnetic field is proposed as a possible explanation for claimed psychokinetic effects (PK). Topologically quantized wormhole magnetic field, being a macroscopic quantum system, can give rise to PK effect via *magnetic levitation*, if external object is wormhole super conductor and if the density of charged wormholes on its boundary is sufficiently high to generate Meissner effect. This same structure could enlarge DNA and other basic structures to macroscopic quantum systems with size much larger than the basic object consisting of ordinary matter. One could even imagine that the structure of DNA sequences could be coded into the structure of the topologically quantized magnetic field created by it.

An alternative model of psychokinesis is based on the possibility of space-time sheets having negative time orientation and carrying therefore negative classical energy. It is not clear whether the space-time sheets associated with the wormhole magnetic fields could have opposite time orientations. This kind of mechanism of energy production might explain claimed poltergeist type effects involving spontaneous gain of kinetic energy. Many-sheeted space-time concept makes possible also psychokinesis based on levitation: what is needed that subsystem is able to topologically condense to a sufficiently large space-time sheet carrying very weak gravitational fields.

This chapter describes the view about wormhole contacts as it was for more than decade ago. The recent identification of wormhole contacts is as bosons with positive and negative energy fermion and anti-fermion at the opposite light-like throats of the contact. This allows to identify also virtual gauge bosons as pairs of on mass shell fermions. Virtual fermions could correspond

to wormhole contacts with second contact identifiable as Fock vacuum. Also super-symmetric partners of these states obtained by applying fermionic oscillator operator algebra correspond to particle like states. Therefore wormhole contacts might not represent completely new physics and be identifiable as gauge boson like or Higgs like states. If the wormhole throat carries magnetic flux it could define a dyonlike partner of ordinary gauge boson or Higgs.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. Pdf representation of same files serving as a kind of glossary can be found at <http://tgdtheory.fi/tgdglossary.pdf> [L1].

## 2 Basic Conceptual Framework

The notions of topological condensate and p-adic length scale hierarchy are in a central role in TGD and for a long time it seemed that the physical interpretation of these notions is relatively straightforward. The evolution of number theoretical ideas however forced to suspect that the implications for physics might be much deeper and involve not only a solution to the mysteries of dark matter but also force to bring basic notions of TGD inspired theory of consciousness. At this moment the proper interpretation of the mathematical structures involving typically infinite hierarchies generalizing considerably the mathematical framework of standard physics is far from established so that it is better to represent just questions with some plausible looking answers.

### 2.1 Basic Concepts

It is good to discuss the basic notions before discussing the definition of gauge charges and gauge fluxes.

#### 2.1.1 $CP_2$ type vacuum extremals

$CP_2$  type extremals behave like elementary particles (in particular, light-likeness of  $M^4$  projection gives rise to Virasoro conditions).  $CP_2$  type vacuum extremals have however vanishing four-momentum although they carry classical color charges. This raises the question how they can gain elementary particle quantum numbers.

In topological condensation of  $CP_2$  type vacuum extremal a light-like causal horizon is created. Number theoretical considerations strongly suggest that the horizon carries elementary particle numbers and can be identified as a parton. The quantum numbers or parton would serve as sources of the classical gauge fields created by the causal horizon.

In topological evaporation  $CP_2$  type vacuum extremal carrying only classical color charges is created. This would suggest that the scattering of  $CP_2$  type vacuum extremals defines a topological quantum field theory resulting as a limit of quantum gravitation ( $CP_2$  is gravitational instanton) and that  $CP_2$  type extremals define the counterparts of vacuum lines appearing in the formulation of generalized Feynman diagrams.

#### 2.1.2 Wormhole contacts as parton pairs

The earlier view about wormhole (#) contacts (see **Fig.** <http://tgdtheory.fi/appfigures/wormholecontact.jpg> or **Fig. ??** in the appendix of this book) as passive mediators of classical gauge and gravitational fluxes is not quite correct. The basic modification is due to the fact that one can assign parton or parton pair to the # contact so that it becomes a particle like entity. This means that an entire p-adic hierarchy of new physics is predicted.

1. Formally # contact can be constructed by drilling small spherical holes  $S^2$  in the 3-surfaces involved and connecting the spherical boundaries by a tube  $S^2 \times D^1$ . For instance,  $CP_2$  type extremal can be glued to space-time sheet with Minkowskian signature or space-time sheets with Minkowskian signature can be connected by # contact having Euclidian signature of the induced metric. Also more general contacts are possible since  $S^2$  can be replaced with a 2-surface of arbitrary genus and family replication phenomenon can be interpreted in terms of the genus.

The  $\#$  contact connecting two space-time sheets with Minkowskian signature of metric is accompanied by two “elementary particle horizons”, which are light-like 3-surfaces at which the induced 4-metric becomes degenerate. Since these surfaces are causal horizons, it is not clear whether  $\#$  contacts can mediate classical gauge interactions. If there is an electric gauge flux associated with elementary particle horizon it tends to be either infinite by the degeneracy of the induced metric. It is not clear whether boundary conditions allow to have finite gauge fluxes of electric type. A similar difficulty is encountered when one tries to assign gravitational flux to the  $\#$  contact: in this case even the existence of flux in non-singular case is far from obvious. Hence the naïve extrapolation of Newtonian picture might not be quite correct.

2. Number theoretical considerations suggests that the two light-like horizons associated with  $\#$  contacts connecting space-time sheets act as dynamical units analogous to shock waves or light fronts carrying quantum numbers so that the identification as partons is natural. Quantum holography would suggest itself in the sense that the quantum numbers associated with causal horizons would determine the long range fields inside space-time sheets involved.
3.  $\#$  contacts can be modelled in terms of  $CP_2$  type extremals topologically condensed simultaneously to the two space-time sheets involved. The topological condensation of  $CP_2$  type extremal creates only single parton and this encourages the interpretation as elementary particle. The gauge currents for  $CP_2$  type vacuum extremals have a vanishing covariant divergence so that there are no conserved charges besides Kähler charge. Hence electro-weak gauge charges are not conserved classically in the region between causal horizons whereas color gauge charges are. This could explain the vacuum screening of electro-weak charges at space-time level. This is required since for the known solutions of field equations other than  $CP_2$  type extremals vacuum screening does not occur.
4. In the special case space-time sheets have opposite time orientations and the causal horizons carry opposite quantum numbers (with four-momentum included) the  $\#$  contact would serve the passive role of flux mediator and one could assign to the contact generalized gauge fluxes as quantum numbers associated with the causal horizons. This is the case if the contact is created from vacuum in topological condensation so that the quantum numbers associated with the horizons define naturally generalized gauge fluxes. Kind of generalized quantum dipoles living in two space-times simultaneously would be in question.  $\#$  contacts in the ground state for space-time sheets with opposite time orientation can be also seen as zero energy parton-antiparton pairs bound together by a piece of  $CP_2$  type extremal.
5. When space-time sheets have same time orientation, the two-parton state associated with the  $\#$  contact has non-vanishing energy and it is not clear whether it can be stable.

### 2.1.3 $\#_B$ contacts as bound parton pairs

Besides  $\#$  contacts also flux tubes (JABs,  $\#_B$  contacts) are possible. They can connect outer boundaries of space-time sheets or the boundaries of small holes associated with the interiors of two space-time sheets which can have Minkowskian signature of metric and can mediate classical gauge fluxes and are excellent candidates for mediators of gauge interactions between space-time sheet glued to a larger space-time sheet by topological sum contacts and join along boundaries contacts. The size scale of the causal horizons associated with parton pairs can be arbitrary whereas the size scale of  $\#$  contacts is given by  $CP_2$  radius.

Consider first the original vision about JABs. The original belief was that the existence of the holes for real space-time surfaces is a natural consequence of the induced gauge field concept: for sufficiently strong gauge fields the imbeddability of gauge field as an induced gauge field fails and hole in space-time appears as a consequence. The holes connected by  $\#_B$  contacts obey field equations, and a good guess is that they are light-like 3-surfaces and carry parton quantum numbers. This would mean that both  $\#$  and  $\#_B$  contacts allow a fundamental description in terms of pair of partons.

Magnetic flux tubes provide a representative example of  $\#_B$  contact. Instead of  $\#_B$  contact also more descriptive terms such as join along boundaries bond (JAB), color bond, and magnetic

flux tube are used.  $\#_B$  contacts serve also as a space-time correlate for bound state formation and one can even consider the possibility that entanglement might have braiding of bonds defined by  $\#$  contacts as a space-time correlate [K1].

It seems difficult to exclude flux tubes between holes associated with the two space-time sheets at different levels of p-adic hierarchy. If these contacts are possible, a transfer of conserved gauge fluxes would be possible between the two space-time sheets and one could speak about interaction in conventional sense.

The most recent TGD view about JABs is different. The recent belief is that boundaries- and jus JABs- are not allowed by the boundary conditions: space-time sheets with boundary are replaced with their double covers. Furthermore, elementary particles and also larger systems correspond to space-time regions which as lines of generalized Feynman diagrams have Euclidian signature of the induced metric. This suggests that magnetic flux tubes as deformations of cosmic strings have Euclidian signature of metric too. This is quite possible and in the simplest situation would require that string world sheet has Euclidian signature of the induced metric. JABs in this sense would serve as correlates of quantum entanglement between system that they connect together.

Double cover property means that JABs identified as Kähler magnetic flux tubes have cross section, which are closed surfaces, and thus can carry quantized Kähler magnetic flux. These flux tubes would provide correlates for the magnetic fields known to exist in cosmological scales but no possible in standard cosmology due to the fact that needed currents should be coherent in long scales. For monopole fluxes no currents are needed.

#### 2.1.4 Wormhole contacts as bosons and their super partners

The original interpretation of wormhole contacts (see **Fig.** <http://tgdtheory.fi/appfigures/wormholecontact.jpg> or **Fig.** ?? in the appendix of this book) was as genuinely new kind of particle like objects. With the emergence of zero energy ontology it gradually became clear that ordinary gauge bosons and Higgs particle and their super partners can be identified as wormhole contacts. Free fermions and their super-partners would be identified as  $CP_2$  type vacuum extremals glued to a space-time sheet with a Minkowskian signature of the induced metric and thus possessing only single wormhole throat identified as a light-like 3-surface.

This identification has far reaching implications. For instance, off mass shell particles can be interpreted as pairs of on mass shell positive and negative energy states at the opposite throats of the wormhole contact. This representation of virtual particles is crucial for the generalization of twistor formalism to TGD framework [K31].

A possible interpretation of wormhole contacts in living matter is as scaled up variants of bosons having much smaller mass and massless below confinement scale and appropriate p-adic length scale. This would mean the existence of scaled up copies of QCD type physics and electro-weak physics. These phases could be dark and characterized by a large value of Planck constant.

#### 2.1.5 Topological condensation and evaporation

Topological condensation corresponds to a formation of  $\#$  or  $\#_B$  contacts between space-time sheets. Topological evaporation means the splitting of  $\#$  or  $\#_B$  contacts. In the case of elementary particles the process changes almost nothing since the causal horizon carrying parton quantum numbers does not disappear. The evaporated  $CP_2$  type vacuum extremal having interpretation as a gravitational instanton can carry only color quantum numbers.

As  $\#$  contact splits partons are created at the two space-time sheets involved. This process can obviously generate from vacuum space-time sheets carrying particles with opposite signs of energies and other quantum numbers. Positive energy matter and negative energy anti-matter could be thus created by the formation of  $\#$  contacts with zero net quantum numbers which then split to produce pair of positive and negative energy particles at different space-time sheets having opposite time orientations. This mechanism would allow a creation of positive energy matter and negative energy antimatter with an automatic separation of matter and antimatter at space-time sheets having different time orientation. This might resolve elegantly the puzzle posed by matter-antimatter asymmetry.



The creation of  $\#$  contact leads to an appearance of radial gauge field in condensate and this seems to be impossible at the limit of infinitely large space-time sheet since it involves a radical instantaneous change in field line topology. The finite size of the space-time sheet can however resolve the difficulty.

If all quantum numbers of elementary particle are expressible as gauge fluxes, the quantum numbers of topologically evaporated particles should vanish. In the case of color quantum numbers and Poincare quantum numbers there is no obvious reason why this should be the case. Despite this the cancellation of the interior quantum numbers by those at boundaries or light-like causal determinants could occur and would conform with the effective 2-dimensionality stating that quantum states are characterized by partonic boundary states associated with causal determinants. This could be also seen as a holographic duality of interior and boundary degrees of freedom [K28].

## 2.2 Gauge Charges And Gauge Fluxes

The concepts of mass and gauge charge in TGD has been a source of a chronic headache. There are several questions waiting for a definite answer. How to define gauge charge? What is the microscopic physics behind the gauge charges necessarily accompanying long range gravitational fields? Are these gauge charges quantized in elementary particle level? Can one associate to elementary particles classical electro-weak gauge charges equal to its quantized value or are all electro-weak charges screened at intermediate boson length scale? Is the generation of the vacuum gauge charges, allowed in principle by the induced gauge field concept, possible in macroscopic length scales? What happens to the gauge charges in topological evaporation? Should Equivalence Principle be modified in order to understand the fact that Robertson-Walker metrics are inertial but not gravitational vacua. Or is there some other way to solve the problem.

### 2.2.1 How to define the notion of gauge charge?

In TGD gauge fields are not primary dynamical variables but induced from the spinor connection of  $CP_2$ . There are two ways to define gauge charges.

1. In purely group theoretical approach one can associate non-vanishing gauge charge to a 3-surface of finite size and quantization of the gauge charge follows automatically. This definition should work at Planck length scales, when particles are described as 3-surfaces of  $CP_2$  size and classical space-time mediating long range interactions make no sense. Gauge interactions are mediated by gauge boson exchange, which in TGD has topological description in terms of  $CP_2$  type extremals [K32].
2. Second definition of gauge charge is as a gauge flux over a closed surface. In this case quantization is not obvious nor perhaps even possible at classical level except perhaps for Abelian charges. For a closed 3-surface gauge charge vanishes and one might well argue that this is the case for finite 3-surface with boundary since the boundary conditions might well generate gauge charge near the boundary cancelling the gauge charge created by particles condensed on 3-surface. This would mean that at low energies (photon wavelength large than size of the 3-surfaces) the 3-surfaces in vapor phase look like neutral particles. Only at high energies the evaporated particles would behave as ordinary elementary particles. Furthermore, particle leaves in topological evaporation its gauge charge in the condensate.

The alternative possibility that the long range  $\frac{1}{r^2}$  gauge field associated with particle disappears in the evaporation, looks topologically impossible at the limit when larger space-time sheet has infinite size: only the simultaneous evaporation of opposite gauge charges might be possible in this manner at this limit. Topological evaporation provides a possible mechanism for the generation of vacuum gauge charges, which is one basic difference between TGD and standard gauge theories.

There is a strong temptation to draw a definite conclusion but it is better to be satisfied with a simplifying working hypothesis that gauge charges are in long length scales definable as gauge fluxes and vanish for macroscopic 3-surfaces of finite size in vapor phase. This would mean that the topological evaporation of say electron as an electromagnetically charged particle would not be possible except at  $CP_2$  length scale: in the evaporation from secondary condensation level electron

would leave its gauge charges in the condensate. Vapor phase particle still looks electromagnetically charged in length scales smaller than the size of the particle surface if the neutralizing charge density is near (or at) the boundary of the surface and gauge and gravitational interactions are mediated by the exchange of  $CP_2$  type extremals.

### 2.2.2 In what sense could # contacts feed gauge fluxes?

One can associate with the # throats magnetic gauge charges  $\pm Q_i$  defined as gauge flux running to or from the throat. The magnetic charges are of opposite sign and equal magnitude on the two space-time sheets involved. For Kähler form the value of magnetic flux is quantized and non-vanishing only if the  $t = \text{constant}$  section of causal horizon corresponds to a non-trivial homology equivalence class in  $CP_2$  so that # contact can be regarded as a homological magnetic monopole. In this case # contacts can be regarded as extremely small magnetic dipoles formed by tightly bound # throats possessing opposite magnetic gauge charges. # contacts couple to the difference of the classical gauge fields associated with the two space-time sheets and matter-# contact and # contact-# contact interaction energies are in general non-vanishing.

Electric gauge fluxes through # throat evaluated at the light-like elementary particle horizon  $X_i^3$  tend to be either zero or infinite. The reason is that without appropriate boundary conditions the normal component of electric  $F^{tn}\sqrt{(g_4)}/g^2$  either diverges or is infinite since  $g^{tt}$  diverges by the effective three-dimensionality of the induced metric at  $X_i^3$ . In the gravitational case an additional difficulty is caused by the fact that it is not at all clear whether the notion of gravitational flux is well defined. It is however possible to assign gravitational mass to a given space-time sheets as will be found in the section about space-time description of charge renormalization.

The simplest conclusion would be that the notions of gauge and gravitational fluxes through # contacts do not make sense and that # contacts mediate interactions in a more subtle manner. For instance, for a space-time sheet topologically condensed at a larger space-time sheet the larger space-time sheet would characterize the basic coupling constants appearing in the S-matrix associated with the topologically condensed space-time sheets. In particular, the value of  $\hbar$  would characterize the relation between the two space-time sheets. A stronger hypothesis would be that the value of  $\hbar$  is coded partially by the Jones inclusion between the state spaces involved. The larger space-time sheet would correspond to dark matter from the point of view of smaller space-time sheet [K34, K11].

One can however try to find loopholes in the argument.

1. It might be possible to pose the finiteness of  $F^{tn}\sqrt{g_4}/g^2$  as a boundary condition. The variation principle determining space-time surfaces implies that space-time surfaces are analogous to Bohr orbits so that there are also hopes that gauge fluxes are quantized.
2. Another way out of this difficulty could be based on the basic idea behind renormalization in TGD framework. Gauge coupling strengths are allowed to depend on space-time point so that the gauge currents are conserved. Gauge coupling strengths  $g^2/4\pi$  could become infinite at causal horizon. The infinite values of gauge couplings at causal horizons might be a TGD counterpart for the infinite values of bare gauge couplings in quantum field theories. There are however several objections against this idea. The values of coupling constants should depend on space-time sheet only so that the situation is not improved by this trick in  $CP_2$  length scale. Dependence of  $g^2$  on space-time point means also that in the general case the definition of gauge charge as gauge flux is lost so that gauge charges do not reduce to fluxes.

It seems that the notion of a finite electric gauge flux through the causal horizon need not make sense as such. Same applies to the notion of gravitational gauge flux. The notion of gauge flux seems however to have a natural quantal generalization. The creation of a # contact between two space-time sheets creates two causal horizons identifiable as partons and carrying conserved charges assignable with the states created using the fermionic oscillator operators associated with the second quantized induced spinor field. These charges must be of opposite sign so that electric gauge fluxes through causal horizons are replaced by quantal gauge charges. For opposite time orientations also four-momenta cancel each other. The particle states can of course transform by interactions with matter at the two-space-time sheets so that the resulting contact is not a zero energy state always.

This suggests that for gauge fluxes at the horizon are identifiable as opposite quantized gauge charges of the partons involved. If the net gauge charges of  $\#$  contact do not vanish, it can be said to possess net gauge charge and does not serve as a passive flux mediator anymore. The possibly screened classical gauge fields in the region faraway from the contact define the classical correlates for gauge fluxes. A similar treatment applies to gravitational flux in the case that the time orientations are opposite and gravitational flux is identifiable as gravitational mass at the causal horizon.

Internal consistency would mildly suggest that  $\#$  contacts are possible only between space-time sheets of opposite time orientation so that gauge fluxes between space-time sheets of same time orientation would flow along  $\#_B$  bonds.

### 2.2.3 Are the gauge fluxes through $\#$ and $\#_B$ contacts quantized?

There are good reasons (the fact that the extremals are critical in the sense that they allow an infinite number of deformations with a vanishing second variation of Kähler action plus maximization of the Kähler function) to expect that the gauge fluxes through  $\#$  (if well-defined) and  $\#_B$  contacts are quantized.

The expectation is that the number of critical deformations defining the symmetries is infinite and conformal symmetries are in question. The conformal algebras would form an infinite hierarchy of sub-algebras with generators labelled by integers proportional to an integer  $n = 1, 2, \dots$ . One would have  $n$  conformal equivalence classes of space-time surfaces connecting given 3-surfaces at the boundaries of CD and  $n$  would define Planck constant  $h_{eff} = n \times h$  labelling the hierarchy of dark matters (see **Fig.** <http://tgdtheory.fi/appfigures/planckhierarchy.jpg> or **Fig. ??** in the appendix of this book).

The most natural guess would be that the unit of electric electromagnetic flux for  $\#_B$  contact is  $1/3$  since this makes it possible for the electromagnetic gauge flux of quarks to flow to larger space-time sheets. Anyons could however mean more general quantization rules [K1]. The quantization of electromagnetic gauge flux could serve as a unique experimental signature for  $\#$  and  $\#_B$  contacts and their currents. The contacts can carry also magnetic fluxes. In the case of  $\#_B$  contacts the flux quantization would be dynamical and analogous to that appearing in super conductors.

### 2.2.4 Hierarchy of gauge and gravitational interactions

The observed elementary particles are identified as  $CP_2$  type extremals topologically condensed at space-time sheets with Minkowski signature of induced metric with elementary particle horizon being responsible for the parton aspect. This suggests that at  $CP_2$  length scale gauge and gravitational interactions correspond to the exchanges of  $CP_2$  type extremals with light-like  $M^4$  projection with branching of  $CP_2$  type extremal serving as the basic vertex as discussed in [K32]. The gravitational and gauge interactions between the partons assignable to the two causal horizons associated with  $\#$  contact would be mediated by the  $\#$  contact, which can be regarded as a gravitational instanton and the interaction with other particles at space-time sheets via classical gravitational fields.

Gauge fluxes flowing through the  $\#_B$  contacts would mediate higher level gauge and interactions between space-time sheets rather than directly between  $CP_2$  type extremals. The hierarchy of flux tubes defining string like objects strongly suggests a p-adic hierarchy of “strong gravities” with gravitational constant of order  $G \sim L_p^2$ , and these strong gravities might correspond to gravitational fluxes mediated by the flux tubes.

## 2.3 The Relationship Between Inertial And Gravitational Masses

The understanding of the relationship between TGD and GRT and quantum and classical variants of Equivalence Principle (EP) in TGD have developed rather slowly but the recent picture is rather feasible.

1. The recent view is that EP at quantum level reduces to Quantum Classical Correspondence (QCC) in the sense that Cartan algebra Noether charges assignable to 3-surface in case of Kähler action (inertial charges) are identical with eigenvalues of the quantal variants of Noether charges for Kähler-Dirac action (gravitational charges). The well-definedness of the

latter charges is due to the conformal invariance assignable to 2-D surfaces (string world sheets and possibly partonic 2-surfaces) at which the spinor modes are localized in generic case. This localization follows from the condition that em charge has well defined value for the spinor modes. The localization is possibly only for the Kähler-Dirac action and key role is played by the modification of gamma matrices to Kähler-Dirac gamma matrices. The gravitational four-momentum is thus completely analogous to stringy four-momentum.

2. At classical level EP follows from the interpretation of GRT space-time as effective space-time obtained by replacing many-sheeted space-time with Minkowski space with effective metric determined as a sum of Minkowski metric and sum over the deviations of the induced metrics of space-time sheets from Minkowski metric. Poincare invariance suggests strongly classical EP for the GRT limit in long length scales at least (see **Fig.** <http://tgdtheory.fi/appfigures/manysheeted.jpg> or **Fig.** 9 in the appendix of this book).

### 2.3.1 ZEO and non-conservation of Poincare charges in Poincare invariant theory of gravitation

In positive energy ontology the Poincare invariance of TGD is in sharp contrast with the fact that GRT based cosmology predicts non-conservation of Poincare charges (as a matter fact, the definition of Poincare charges is very questionable for general solutions of field equations).

In zero energy ontology (ZEO) all conserved (that is Noether-) charges of the Universe vanish identically and their densities should vanish in scales below the scale defining the scale for observations and assignable to causal diamond (CD). This observation allows to imagine a ways out of what seems to be a conflict of Poincare invariance with cosmological facts.

ZEO would explain the local non-conservation of average energies and other conserved quantum numbers in terms of the contributions of sub-CDs analogous to quantum fluctuations. Classical gravitation should have a thermodynamical description if this interpretation is correct. The average values of the quantum numbers assignable to a space-time sheet would depend on the size of CD and possibly also its location in  $M^4$ . If the temporal distance between the tips of CD is interpreted as a quantized variant of cosmic time, the non-conservation of energy-momentum defined in this manner follows. One can say that conservation laws hold only true in given scale defined by the largest CD involved.

### 2.3.2 Equivalence Principle at quantum level

The interpretation of EP at quantum level has developed slowly and the recent view is that it reduces to quantum classical correspondence meaning that the classical charges of Kähler action can be identified with eigen values of quantal charges associated with Kähler-Dirac action.

1. At quantum level I have proposed coset representations for the pair of super-symplectic algebras assignable to the light-like boundaries of CD and the Super Kac-Moody algebra assignable to the light-like 3-surfaces defining the orbits of partonic 2-surfaces as realization of EP. For coset representation the differences of super-conformal generators would annihilate the physical states so that one can argue that the corresponding four-momenta are identical. One could even say that one obtains coset representation for the “vibrational” parts of the super-conformal algebras in question. It is now clear that this idea does not work. Note however that coset representations occur naturally for the subalgebras of symplectic algebra and Super Kac-Moody algebra and are naturally induced by finite measurement resolution.
2. The most recent view (2014) about understanding how EP emerges in TGD is described in [K33] and relies heavily on superconformal invariance and a detailed realisation of ZEO at quantum level. In this approach EP corresponds to quantum classical correspondence (QCC): four-momentum identified as classical conserved Noether charge for space-time sheets associated with Kähler action is identical with quantal four-momentum assignable to the representations of super-symplectic and super Kac-Moody algebras as in string models and having a realisation in ZEO in terms of wave functions in the space of causal diamonds (CDs).
3. The latest realization is that the eigenvalues of quantal four-momentum can be identified as eigenvalues of the four-momentum operator assignable to the Kähler-Dirac equation. This

realisation seems to be consistent with the p-adic mass calculations requiring that the super-conformal algebra acts in the tensor product of 5 tensor factors.

### 2.3.3 Equivalence Principle at classical level

How Einstein's equations and General Relativity in long length scales emerges from TGD has been a long-standing interpretational problem of TGD.

The first proposal making sense even when one does not assume ZEO is that vacuum extremals are only approximate representations of the physical situation and that small fluctuations around them give rise to an inertial four-momentum identifiable as gravitational four-momentum identifiable in terms of Einstein tensor. EP would hold true in the sense that the average gravitational four-momentum would be determined by the Einstein tensor assignable to the vacuum extremal. This interpretation does not however take into account the many-sheeted character of TGD space-time and is therefore questionable.

The resolution of the problem came from the realization that GRT is only an effective theory obtained by endowing  $M^4$  with effective metric.

1. The replacement of superposition of fields with superposition of their effects means replacing superposition of fields with the set-theoretic union of space-time surfaces. Particle experiences sum of the effects caused by the classical fields at the space-time sheets (see **Fig.** <http://tgdtheory.fi/appfigures/fieldsuperpose.jpg> or **Fig. ??** in the appendix of this book).
2. This is true also for the classical gravitational field defined by the deviation from flat Minkowski metric in standard  $M^4$  coordinates for the space-time sheets. One can define effective metric as sum of  $M^4$  metric and deviations. This effective metric would correspond to that of General Relativity. This resolves long standing issues relating to the interpretation of TGD.
3. Einstein's equations could hold true for the effective metric. They are motivated by the underlying Poincare invariance which cannot be realized as global conservation laws for the effective metric. The conjecture vanishing of divergence of Kähler energy momentum tensor can be seen as the microscopic justification for the claim that Einstein's equations hold true for the effective space-time.
4. The breaking of Poincare invariance could have interpretation as effective breaking in zero energy ontology (ZEO), in which various conserved charges are length dependent and defined separately for each causal diamond (CD).

One can of course consider the possibility that Einstein's equations generalize for preferred extremals of Kähler action. This would actually represent at space-time level the notion of QCC rather than realise QCC interpreted as EP. The condition that the energy momentum tensor for Kähler action has vanishing covariant divergence would be satisfied in GRT if Einstein's equations with cosmological term hold true. This is the case also now but one can consider also more general solutions in which one has two cosmological constants which are not genuine constants anymore: it however seems that this option is not promising.

An interesting question is whether inertial-gravitational duality generalizes to the case of color gauge charges so that color gauge fluxes would correspond to "gravitational" color charges and the charges defined by the conserved currents associated with color isometries would define "inertial" color charges. Since the induced color fields are proportional to color Hamiltonians multiplied by Kähler form they vanish identically for vacuum extremals in accordance with "gravitational" color confinement.

### 2.3.4 Gravitational mass is necessarily accompanied by non-vanishing gauge charges

The experience from the study of the extremals of the Kähler action [K3] suggests that for non-vacuum extremals at astrophysical scales Kähler charge doesn't depend on the properties of the condensate and is apart from numerical constant equal to the gravitational mass of the system using Planck mass as unit:

$$Q_K = \epsilon_1 \frac{M_{gr}}{m_{proton}} . \quad (2.1)$$

The condition  $\frac{\epsilon_1}{\sqrt{\alpha_K}} < 10^{-19}$  must hold true in astrophysical length scales since the long range gauge force implied by the Kähler charge must be weaker than gravitational interaction at astrophysical length scales. It is not clear whether the “anomalous” Kähler charge can correspond to a mere  $Z^0$  gauge or em charge or more general combination of weak charges.

Also for the embedding of Schwarzschild and Reissner-Nordström metrics as vacuum extremals non-vanishing gravitational mass implies that some electro-weak gauge charges are non-vanishing [K3]. For vacuum extremals with  $\sin^2(\theta_W) = 0$  em field indeed vanishes whereas  $Z^0$  gauge field is non-vanishing.

If one assumes that the weak charges are screened completely in electro-weak length scale, the anomalous charge can be only electromagnetic if it corresponds to ordinary elementary particles. This however need not be consistent with field equations. Perhaps the most natural interpretation for the “anomalous” gauge charges is due to the elementary charges associated with dark matter. Since weak charges are expected to be screened in the p-adic length scale characterizing weak boson mass scale, the implication is that scaled down copies of weak bosons with arbitrarily small mass scales and arbitrarily long range of interaction are predicted. Also long ranged classical color gauge fields are unavoidable which forces to conclude that also a hierarchy of scaled down copies of gluons exists.

One can hope that photon and perhaps also  $Z^0$  and color gauge charges in Cartan algebra could be quantized classically at elementary particle length scale ( $p \leq M_{127}$ , say) and electromagnetic gauge charge in all length scales apart from small renormalization effects. One of the reasons is that classical electromagnetic fields make an essential part in the description of, say, hydrogen atom.

The study of the extremals of Kähler action and of the embeddings of spherically symmetric metrics [K3, K33] shows that the embeddings are characterized by frequency type vacuum quantum numbers, which allow to fix these charges to pre-determined values. The minimization of Kähler action for a space-time surface containing a given 3-surface leads to the quantization of the vacuum parameters and hopefully to charge quantization. This motivates the hypothesis that the electromagnetic charges associated with the classical gauge fields of topologically condensed elementary particles are equal to their quantized counterparts. The discussion of dark matter leads to the conclusion that electro-weak and color gauge charges of dark matter can be non-vanishing [K11, K9].

## 2.4 Can One Regard # *Resp.* #<sub>B</sub> Contacts As Particles *Resp.* String Like Objects?

#-contacts have obvious particle like aspects identifiable as either partons or parton pairs. #<sub>B</sub> contacts in turn behave like string like objects. Using the terminology of M-theory, #<sub>B</sub> contacts connecting the boundaries of space-time sheets could be also seen as string like objects connecting two branes. Again the ends holes at the ends of #<sub>B</sub> contacts carry well defined gauge charges.

### 2.4.1 # contacts as particles and #<sub>B</sub> contacts as string like objects?

The fact that # contacts correspond to parton pairs raises the hope that it is possible to apply p-adic thermodynamics to calculate the masses of # contact and perhaps even the masses of the partons. If this the case, one has an order of magnitude estimate for the first order contribution to the mass of the parton as  $m \sim 1/L(p_i)$ ,  $i = 1, 2$ . It can of course happen that the first order contribution vanishes: in this case an additional factor  $1/\sqrt{p_i}$  appears in the estimate and makes the mass extremely small.

For # contacts connecting space-time sheets with opposite time orientations the vanishing of the net four-momentum requires  $p_1 = p_2$ . According to the number theoretic considerations below it is possible to assign several p-adic primes to a given space-time sheet and the largest among them, call it  $p_{max}$ , determines the p-adic mass scale. The milder condition is that  $p_{max}$  is same for the two space-time sheets.

There are some motivations for the working hypothesis that  $\#$  contacts and the ends of  $\#_B$  contacts feeding the gauge fluxes to the lower condensate levels or vice versa tend to be located near the boundaries of space-time sheets. For gauge charges which are not screened by vacuum charges (em and color charges) the embedding of the gauge fields created by the interior gauge charges becomes impossible near the boundaries and the only possible manner to satisfy boundary conditions is that gauge fluxes flow to the larger space-time sheet and space-time surface becomes a vacuum extremal of the Kähler action near the boundary.

For gauge bosons the density of boundary  $\#_B$  contacts should be very small in length scales, where matter is essentially neutral. For gravitational  $\#_B$  contacts the situation is different. One might well argue that there is some upper bound for the gravitational flux associated with single  $\#$  or  $\#_B$  contact (or equivalently the gravitational mass associated with causal horizon) given by Planck mass or  $CP_2$  mass so that the number of gravitational contacts is proportional to the mass of the system.

The TGD based explanation for Podkletnov effect [H4] is based on the assumption that magnetically charged  $\#$  contacts are carries of gravitational flux equal to Planck mass and predicts effect with correct order of magnitude. The model generalizes also to the case of  $\#_B$  contacts. The lower bound for the gravitational flux quantum must be rather small: the mass  $1/L(p)$  determined by the p-adic prime associated with the larger space-time sheet is a first guess for the unit of flux.

#### 2.4.2 Could $\#$ and $\#_B$ contacts form Bose-Einstein condensates?

The description as  $\#$  contact as a parton pair suggests that it is possible to assign to  $\#$  contacts inertial mass, say of order  $1/L(p)$ , they should be describable using d'Alembert type equation for a scalar field.  $\#$  contacts couple dynamically to the geometry of the space-time since the induced metric defines the d'Alembertian. There is a mass gap and hence  $\#$  contacts could form a Bose-Einstein (BE) condensate to the ground state. If  $\#$  contacts are located near the boundary of the space-time surface, the d'Alembert equation would be 3-dimensional. One can also ask whether  $\#$  contacts define a particular form of dark matter having only gravitational interactions with the ordinary matter.

Also the probability amplitudes for the positions of the ends of  $\#_B$  contacts located at the boundary of the space-time sheet could be described using an order parameter satisfying d'Alembert equation with some mass parameter and whether the notion of Bose-Einstein condensate makes sense also now. The model for atomic nucleus assigns to the ends of the  $\#_B$  contact realized as a color magnetic flux tube quark and anti-quark with mass scale given by  $k = 127$  (MeV scale) [K29].

This inspires the question whether  $\#$  and  $\#_B$  contacts could be essential for understanding bio-systems as macroscopic quantum systems [K7]. The BE condensate associated with the  $\#$  contacts behaves in many respects like super conductor: for instance, the concept of Josephson junction generalizes. As a matter fact, it seems that  $\#_B$  contacts, join along boundaries (JABs), or magnetic flux tubes could indeed be a key element of not only living matter but even nuclear matter and condensed matter in TGD Universe. Whether boundaries (and thus JABs) are allowed depends on whether boundary conditions for Kähler action allow space-like or light-like boundaries and in the simplest situation they do not seem to be allowed.

Decades after writing these lines it has become clear that Kähler action need not allow boundaries in the usual sense. They would be replaced with boundaries between space-time regions with Minkowskian and Euclidian signature and magnetic flux tubes carrying possibly monopole flux would replace join along boundaries contacts.

## 2.5 TGD Based Description Of External Fields

The description of a system in external field provides a nontrivial challenge for TGD since the system corresponds now to a p-adic space-time sheet  $k_1$  condensed on background 3-surface  $k_2 > k_1$ . The problem is to understand how external fields penetrate into the smaller space-time sheet and also how the gauge fluxes inside the smaller space-time sheet flow to the external space-time sheet. One should also understand how the penetrating magnetic or electric field manages to preserve its value (if it does so). A good example is provided by the description of system, such as atom or nucleus, in external magnetic or electric field. There are several mechanisms of field penetration:

### 2.5.1 Induction mechanism

In the case of induction fields are mediated from level  $k_1$  to levels  $k_2 \neq k_1$ . The external field at given level  $k_1$  acts on  $\#$  and  $\#_B$  throats (both accompanied by a pair of partons) connecting levels  $k_2$  and  $k_1$ . The motion of  $\#$  and  $\#_B$  contacts, induced by the gauge and gravitational couplings of partons involved to classical gauge and gravitational fields, creates gauge currents serving as sources of classical gauge field at the space-time sheets involved. This mechanism involves “dark” partons not predicted by standard model.

A good example is provided by the rotation of charged  $\#$  throats induced by a constant magnetic field, which in turn creates constant magnetic field inside a cylindrical condensate space-time sheet. A second example is the polarization of the charge density associated with the  $\#$  throats in the external electric field, which in turn creates a constant electric field inside the smaller space-time sheet.

One can in principle formulate general field equations governing the penetration of a classical gauge field from a given condensate level to other levels. The simplified description is based on the introduction of series of fields associated with various condensate levels as analogs of  $H$  and  $B$  and  $D$  and  $E$  fields in the ordinary description of the external fields. The simplest assumption is that the fields are linearly related. A general conclusion is that due to the delicacies of the induced field concept, the fields on higher levels appear in the form of flux quanta and typically the field strengths at the higher condensate levels are stronger so that the penetration of field from lower levels to the higher ones means a decomposition into separate flux tubes.

The description of magnetization in terms of the effective field theory of Weiss introduces effective field  $H$ , which is un-physically strong: a possible explanation as a field consisting of flux quanta at higher condensate levels. A general order of magnitude estimate for field strength of magnetic flux quantum at condensate level  $k$  is as  $1/L^2(k)$ .

### 2.5.2 Penetration of magnetic fluxes via $\#$ contacts

At least magnetic gauge flux can flow from level  $p_1$  to level  $p_2$  via  $\#$  contacts. These surfaces are of the form  $X^2 \times D^1$ , where  $X^2$  is a closed 2-surface. The simplest topology for  $X^2$  is that of sphere  $S^2$ . This leads to the first nontrivial result. If a nontrivial magnetic flux flows through the contact, it is quantized. The reason is that magnetic flux is necessarily over a closed surface.

The concept of induced gauge field implies that magnetic flux is nontrivial only if the surface  $X^2$  is homologically nontrivial:  $CP_2$  indeed allows homologically nontrivial sphere. Ordinary magnetic field can be decomposed into co-homologically trivial term plus a term proportional to Kähler form and the flux of ordinary magnetic field comes only from the part of the magnetic field proportional to the Kähler form and the magnetic flux is an integer multiple of some basic flux.

The proposed mechanism predicts that magnetic flux can change only in multiples of basic flux quantum. In super conductors this kind of behavior has been observed. Dipole magnetic fields can be transported via several  $\#$  contacts: the minimum is one for ingoing and one for return flux so that magnetic dipoles are actual finite sized dipoles on the condensed surface. Also the transfer of magnetic dipole field of, say neutron inside nucleus, to lower condensate level leads to similar magnetic dipole structure on condensate level. For this mechanism the topological condensation of elementary particle, say charged lepton space-time sheet, would involve at least two  $\#$  contacts and the magnetic moment is proportional to the distance between these contacts. The requirement that the magnetic dipole formed by the  $\#$  contacts gives the magnetic moment of the particle gives an estimate for the distance  $d$  between  $\#$  throats: by flux quantization the general order of magnitude is given by  $d \sim \frac{\alpha_{em} 2\pi}{m}$ .

### 2.5.3 Penetration of electric gauge fluxes via $\#$ contacts

For  $\#$  contact for the opposite gauge charges of partons define the value of generalized gauge electric flux between the two space-time sheets. In this case it is also possible to interpret the partons as sources of the fields at the two space-time sheets. If the  $\#$  contacts are near the boundary of the smaller space-time sheet the interpretation as a flow of gauge flux to a larger space-time sheet is perfectly sensible. The partons near the boundary can be also seen as generators of a gauge field compensating the gauge fluxes from interior.



The distance between partons can be much larger than p-adic cutoff length  $L(k)$  and a proper spatial distribution guarantees homogeneity of the magnetic or electric field in the interior. The distances of the magnetic monopoles are however large in this kind of situation and it is an open problem whether this kind of mechanism is consistent with experimental facts.

An estimate for the electric gauge flux  $Q_{em}$  flowing through the # contact is obtained as  $n \sim \frac{E}{QL(k)}$ :  $Q \sim EL^2(k)$ , which is of same order of magnitude as electric gauge flux over surface of area  $L^2(k)$ . In magnetic case the estimate gives  $Q_M \sim BL^2(k)$ : the quantization of  $Q_M$  is consistent with homogeneity requirement only provided the condition  $B > \frac{\Phi_0}{L^2(k)}$ , where  $\Phi_0$  is elementary flux quantum, holds true. This means that flux quantization effects cannot be avoided in weak magnetic fields. The second consequence is that too weak magnetic field cannot penetrate at all to the condensed surface: this is certainly the case if the total magnetic flux is smaller than elementary flux quantum. A good example is provided by the penetration of magnetic field into cylindrical super conductor through the end of the cylinder. Unless the field is strong enough the penetrating magnetic field decomposes into vortex like flux tubes or does not penetrate at all.

The penetration of flux via dipoles formed by # contacts from level to a second level in the interior of condensed surface implies phenomena analogous to the generation of polarization (magnetization) in dielectric (magnetic) materials. The conventional description in terms of fields  $H, B, M$  and  $D, E, P$  has nice topological interpretation (which does not mean that the mechanism is actually at work in condensed matter length scales). Magnetization  $M$  (polarization  $P$ ) can be regarded as the density of fictitious magnetic (electric) dipoles in the conventional theory: the proposed topological picture suggests that these quantities essentially as densities for # contact pairs. The densities of  $M$  and  $P$  are of opposite sign on the condensed surface and condensate.  $B = H - M$  corresponds to the magnetic field at condensing surface level reduced by the density  $-M$  of # contact dipoles in the interior.  $H$  denotes the external field at condensate level outside the condensing surface,  $M$  ( $-M$ ) is the magnetic field created by the # contact dipoles at condensate (condensed) level. Similar interpretation can be given for  $D, E, P$  fields. The penetrating field is homogenous only above length scales larger than the distance between # throats of dipoles: p-adic cutoff scale  $L(k)$  gives natural upper bound for this distance: if this is the case and the density of the contacts is at least of order  $n \sim \frac{1}{L^3(k)}$  the penetrating field can be said to be constant also inside the condensed surface.

In condensed matter systems the generation of ordinary polarization and magnetization fields might be related to the permanent # contacts of atomic surfaces with, say,  $k = 139$  level. The field created by the neutral atom contains only dipole and higher multipoles components and therefore at least two # contacts per atom is necessary in gas phase, where flux tubes between atoms are absent. In the absence of external field these dipoles tend to have random directions. In external field # throats behave like opposite charges and their motion in external field generates dipole field. The expression of the polarization field is proportional to the density of these static dipole pairs in static limit. # contacts make possible the penetration of external field to atom, where it generates atomic transitions and leads to the emission of dipole type radiation field, which gives rise to the frequency dependent part of dielectric constant.

#### 2.5.4 Penetration via #<sub>B</sub> contacts

The field can also through #<sub>B</sub> contacts through the boundary of the condensed surface or through the small holes in its interior. The quantization of electric charge quantization would reduce to the quantization of electric gauge flux in #<sub>B</sub> contacts. If there are partons at the ends of contact they affect the gauge gauge flux.

The penetration via #<sub>B</sub> contacts necessitates the existence of join along boundaries bonds starting from the boundary of the condensed system and ending to the boundary component of a hole in the background surface. The field flux flows simply along the 3-dimensional stripe  $X^2 \times D^1$ : since  $X^2$  has boundary no flux quantization is necessary. This mechanism guarantees automatically the homogeneity of the penetrating field inside the condensed system.

An important application for the theory of external fields is provided by bio-systems in which the penetration of classical electromagnetic fields between different space-time sheets should play central role: what makes the situation so interesting is that the order parameter describing the # and #<sub>B</sub> Bose-Einstein condensates carries also phase information besides the information about the strength of the normal component of the penetrating field.

## 2.6 Number Theoretical Considerations

Number theoretical considerations allow to develop more quantitative vision about the how p-adic length scale hypothesis relates to the ideas just described.

### 2.6.1 How to define the notion of elementary particle?

p-Adic length scale hierarchy forces to reconsider carefully also the notion of elementary particle. p-Adic mass calculations led to the idea that particle can be characterized uniquely by single p-adic prime characterizing its mass squared. It however turned out that the situation is probably not so simple.

The work with modelling dark matter suggests that particle could be characterized by a collection of p-adic primes to which one can assign weak, color, em, gravitational interactions, and possibly also other interactions. It would also seem that only the space-time sheets containing common primes in this collection can interact. This leads to the notions of relative and partial darkness. An entire hierarchy of weak and color physics such that weak bosons and gluons of given physics are characterized by a given p-adic prime  $p$  and also the fermions of this physics contain space-time sheet characterized by same p-adic prime, say  $M_{89}$  as in case of weak interactions. In this picture the decay widths of weak bosons do not pose limitations on the number of light particles if weak interactions for them are characterized by p-adic prime  $p \neq M_{89}$ . Same applies to color interactions.

The p-adic prime characterizing the mass of the particle would perhaps correspond to the largest p-adic prime associated with the particle. Graviton which corresponds to infinitely long ranged interactions, could correspond to the same p-adic prime or collection of them common to all particles. This might apply also to photons. Infinite range might mean that the flux tubes mediating these interactions can be arbitrarily long but their transversal sizes are characterized by the p-adic length scale in question.

The natural question is what this collection of p-adic primes characterizing particle means? The hint about the correct answer comes from the number theoretical vision, which suggests that at fundamental level the branching of boundary components to two or more components, completely analogous to the branching of line in Feynman diagram, defines vertices [K30, K32].

1. If space-time sheets correspond holographically to multi-p p-adic topology such that largest  $p$  determines the mass scale, the description of particle reactions in terms of branchings indeed makes sense. This picture allows also to understand the existence of different scaled up copies of QCD and weak physics. Multi-p p-adicity could number theoretically correspond to q-adic topology for  $q = m/n$  a rational number consistent with p-adic topologies associated with prime factors of  $m$  and  $n$  (1/p-adic topology is homeomorphic with p-adic topology).
2. One could also imagine that different p-adic primes in the collection correspond to different space-time sheets condensed at a larger space-time sheet or boundary components of a given space-time sheet. If the boundary topologies for gauge bosons are completely mixed, as the model of hadrons forces to conclude, this picture is consistent with the topological explanation of the family replication phenomenon and the fact that only charged weak currents involve mixing of quark families. The problem is how to understand the existence of different copies of say QCD. The second difficult question is why the branching leads always to an emission of gauge boson characterized by a particular p-adic prime, say  $M_{89}$ , if this p-adic prime does not somehow characterize also the particle itself.

### 2.6.2 What effective p-adic topology really means?

The need to characterize elementary particle p-adically leads to the question what p-adic effective topology really means. p-Adic mass calculations leave actually a lot of room concerning the answer to this question.

1. The naïvest option is that each space-time sheet corresponds to single p-adic prime. A more general possibility is that the boundary components of space-time sheet correspond to different p-adic primes. This view is not favored by the view that each particle corresponds to

a collection of p-adic primes each characterizing one particular interaction that the particle in question participates.

2. A more abstract possibility is that a given space-time sheet or boundary component can correspond to several p-adic primes. Indeed, a power series in powers of given integer  $n$  gives rise to a well-defined power series with respect to all prime factors of  $n$  and effective multi-p-adicity could emerge at the level of field equations in this manner.

One could say that space-time sheet or boundary component corresponds to several p-adic primes through its effective p-adic topology in a hologram like manner. This option is the most flexible one as far as physical interpretation is considered. It is also supported by the number theoretical considerations predicting the value of gravitational coupling constant [K30].

An attractive hypothesis is that only space-time sheets characterized by integers  $n_i$  having common prime factors can be connected by join along boundaries bonds and can interact by particle exchanges and that each prime  $p$  in the decomposition corresponds to a particular interaction mediated by an elementary boson characterized by this prime.

The physics of quarks and hadrons provides an immediate test for this interpretation. The surprising and poorly understood conclusion from the p-adic mass calculations was that the p-adic primes characterizing light quarks u, d, s satisfy  $k_q < 107$ , where  $k = 107$  characterizes hadronic space-time sheet [K18].

1. The interpretation of  $k = 107$  space-time sheet as a hadronic space-time sheet implies that quarks topologically condense at this space-time sheet so that  $k = 107$  cannot belong to the collection of primes characterizing quark.
2. Quark space-time sheets must satisfy  $k_q < 107$  unless  $\hbar$  is large for the hadronic space-time sheet so that one has  $k_{eff} = 107 + 22 = 129$ . This predicts two kinds of hadrons. Low energy hadrons consists of u, d, and s quarks with  $k_q < 107$  so that hadronic space-time sheet must correspond to  $k_{eff} = 129$  and large value of  $\hbar$ . One can speak of confined phase. This allows also  $k = 127$  light variants of quarks appearing in the model of atomic nucleus [K29]. The hadrons consisting of c, t, b and the p-adically scaled up variants of u, d, s having  $k_q > 107$ ,  $\hbar$  has its ordinary value in accordance with the idea about asymptotic freedom and the view that the states in question correspond to short-lived resonances.

### 2.6.3 Do infinite primes code for q-adic effective space-time topologies?

Besides the hierarchy of space-time sheets, TGD predicts, or at least suggests, several hierarchies such as the hierarchy of infinite primes [K30], hierarchy of Jones inclusions [K34], hierarchy of dark matters with increasing values of  $\hbar$  [K11, K9], the hierarchy of extensions of given p-adic number field, and the hierarchy of selves and quantum jumps with increasing duration with respect to geometric time. There are good reasons to expect that these hierarchies are closely related.

#### 1. Some facts about infinite primes

The hierarchy of infinite primes can be interpreted in terms of an infinite hierarchy of second quantized super-symmetric arithmetic quantum field theories allowing a generalization to quaternionic or perhaps even octonionic context [K30]. Infinite primes, integers, and rationals have decomposition to primes of lower level.

Infinite prime has fermionic and bosonic parts having no common primes. Fermionic part is finite and corresponds to an integer containing and bosonic part is an integer multiplying the product of all primes with fermionic prime divided away. The infinite prime at the first level of hierarchy corresponds in a well defined sense a rational number  $q = m/n$  defined by bosonic and fermionic integers  $m$  and  $n$  having no common prime factors.

#### 2. Do infinite primes code for effective q-adic space-time topologies?

The most obvious question concerns the space-time interpretation of this rational number. Also the question arises about the possible relation with the integers characterizing space-time sheets having interpretation in terms of multi-p-adicity. One can assign to any rational number  $q = m/n$  so called q-adic topology. This topology is not consistent with number field property like

p-adic topologies. Hence the rational number  $q$  assignable to infinite prime could correspond to an effective q-adic topology.

If this interpretation is correct, arithmetic fermion and boson numbers could be coded into effective q-adic topology of the space-time sheets characterizing the non-determinism of Kähler action in the relevant length scale range. For instance, the power series of  $q > 1$  in positive powers with integer coefficients in the range  $[0, q)$  define q-adically converging series, which also converges with respect to the prime factors of  $m$  and can be regarded as a p-adic power series. The power series of  $q$  in negative powers define in similar converging series with respect to the prime factors of  $n$ .

I have proposed earlier that the integers defining infinite rationals and thus also the integers  $m$  and  $n$  characterizing finite rational could correspond at space-time level to particles with positive *resp.* negative time orientation with positive *resp.* negative energies. Phase conjugate laser beams would represent one example of negative energy states. With this interpretation super-symmetry exchanging the roles of  $m$  and  $n$  and thus the role of fermionic and bosonic lower level primes would correspond to a time reversal.

1. The first interpretation is that there is single q-adic space-time sheet and that positive and negative energy states correspond to primes associated with  $m$  and  $n$  respectively. Positive (negative) energy space-time sheets would thus correspond to p-adicity ( $1/p$ -adicity) for the field modes describing the states.
2. Second interpretation is that particle (in extremely general sense that entire universe can be regarded as a particle) corresponds to a pair of positive and negative energy space-time sheets labelled by  $m$  and  $n$  characterizing the p-adic topologies consistent with  $m$ - and  $n$ -adicities. This looks natural since Universe has necessary vanishing net quantum numbers. Unless one allows the non-uniqueness due to  $m/n = mr/nr$ , positive and negative energy space-time sheets can be connected only by  $\#$  contacts so that positive and negative energy space-time sheets cannot interact via the formation of  $\#_B$  contacts and would be therefore dark matter with respect to each other.

Positive energy particles and negative energy antiparticles would also have different mass scales. If the rate for the creation of  $\#$  contacts and their CP conjugates are slightly different, say due to the presence of electric components of gauge fields, matter antimatter asymmetry could be generated primordially.

These interpretations generalize to higher levels of the hierarchy. There is a homomorphism from infinite rationals to finite rationals. One can assign to a product of infinite primes the product of the corresponding rationals at the lower level and to a sum of products of infinite primes the sum of the corresponding rationals at the lower level and continue the process until one ends up with a finite rational. Same applies to infinite rationals. The resulting rational  $q = m/n$  is finite and defines q-adic effective topology, which is consistent with all the effective p-adic topologies corresponding to the primes appearing in factorizations of  $m$  and  $n$ . This homomorphism is of course not 1-1.

If this picture is correct, effective p-adic topologies would appear at all levels but would be dictated by the infinite-p p-adic topology which itself could refine infinite-P p-adic topology [K30] coding information too subtle to be caught by ordinary physical measurements.

Obviously, one could assign to each elementary particle infinite prime, integer, or even rational to this a rational number  $q = m/n$ .  $q$  would associate with the particle q-adic topology consistent with a collection of p-adic topologies corresponding to the prime factors of  $m$  and  $n$  and characterizing the interactions that the particle can participate directly. In a very precise sense particles would represent both infinite and finite numbers.

#### 2.6.4 Under what conditions space-time sheets can be connected by $\#_B$ contact?

Assume that particles are characterized by a p-adic prime determining its mass scale plus p-adic primes characterizing the gauge bosons to which they couple and assume that  $\#_B$  contacts mediate gauge interactions. The question is what kind of space-time sheets can be connected by  $\#_B$  contacts.

1. The first working hypothesis that comes in mind is that the p-adic primes associated with the two space-time sheets connected by  $\#_B$  contact must be identical. This would require that particle is many-sheeted structure with no other than gravitational interactions between various sheets. The problem of the multi-sheeted option is that the characterization of events like electron-positron annihilation to a weak boson looks rather clumsy.
2. If the notion of multi-p p-adicity is accepted, space-time sheets are characterized by integers and the largest prime dividing the integer might characterize the mass of the particle. In this case a common prime factor  $p$  for the integers characterizing the two space-time sheets could be enough for the possibility of  $\#_B$  contact and this contact would be characterized by this prime. If no common prime factors exist, only  $\#$  contacts could connect the space-time sheets. This option conforms with the number theoretical vision. This option would predict that the transition to large  $\hbar$  phase occurs simultaneously for all interactions.

### 3 Model For Topologically Quantized Magnetic Field

#### 3.1 Topological Field Quantization

Topological field quantization [K15] implies that various notions of quantum field theory have rather precise classical analogies. Topological field quantization provides the correspondence between the abstract Fock space description of elementary particles and the description of the elementary particles as concrete geometric objects detected in the laboratory. In standard quantum field theory this kind of correspondence is lacking since classical fields are regarded as a phenomenological concept only. Topological field quanta define regions of coherence for the classical fields and classical coherence is the prerequisite of the quantum coherence.

The energies and other classical charges of the topological field quanta are quantized by the criticality of the preferred extremals making classical space-time surfaces the counterparts of the Bohr orbits. Feynman diagrams become classical space-time surfaces with lines thickened to 4-manifolds. For instance, “massless extremals” representing topologically quantized classical radiation fields are the classical counterparts of gravitinos and photons. Topologically quantized non-radiative nearby fields give rise to various geometric structures such as magnetic and electric flux tubes.

The virtual particles of quantum field theory have also classical counterparts. In particular, the virtual particles of quantum field theory can have negative energies: this is true also for the TGD counterparts of the virtual particles. The fundamental difference between TGD and GRT is that in TGD the sign of energy depends on the time orientation of the space-time sheet: this is due to the fact that in TGD energy current is vector field rather than part of tensor field. Therefore space-time sheets with negative energies are possible. This could have quite dramatic technological consequences: consider only the possibility of generating energy from vacuum and classical signalling backwards in time along negative energy space-time sheets [K19, ?]. Also bio-systems might have invented negative energy space-time sheets: in fact, so called “massless extremals” provide an ideal manner to generate coherent motions as recoil effects caused by the creation of negative energy massless extremals [K22, K21]. An interesting possibility is that quantum entanglement has the formation of the join along boundaries bonds/flux tubes as its geometric correlate.

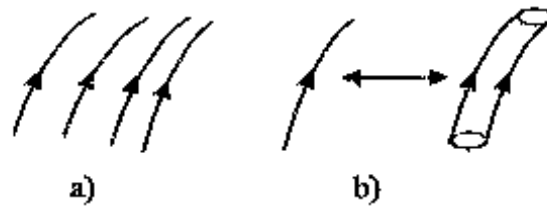
The crucial question is of course “How to make this idea quantitative?”. An attractive possibility is that topological field quanta identified as material or mind-like space-time sheets could be regarded as counterparts of oscillator operators of free fields in quantum field theory. This would mean that one could make order of magnitude estimates for the probabilities for the presence of various numbers of both material and mind-like space-time sheets using quantum field theoretical intuition. The coefficient of a particular state in the expansion of the creation operators of the outgoing interacting quantum fields in terms of the creation and annihilation operators of free quantum fields could provide an estimate for the probability that a particular configuration containing topological field quanta with positive and negative energies results in quantum jump between quantum histories. Since mind-like space-time sheets are correlates for virtual particles, this would also mean a deep connection between quantum field theory and cognition.

Topological field quanta could serve as templates for the formation of the bio-structures. Thus topologically quantized classical electromagnetic fields could be equally important for the function-

ing of the living systems as the structures formed by the visible bio-matter and the visible part of bio-system might represent only a dip of an ice berg.

Topological field quantization of magnetic field (see **Fig. 1**) means that given classical magnetic field is replaced with a bundle of flux tubes flowing along the field lines of classical magnetic field.

In TGD context magnetic flux tubes are really what they look, that is cylindrical 3-surfaces with *boundary* if one assumes that they do not carry monopole flux which is also possible by the topology of  $CP_2$ . Boundary can be present only if one adds to the Kähler action Chern-Simons term as boundary term. The boundary of the flux tube must by Maxwell equations contain rotating em or  $Z^0$  charges creating the magnetic field in the interior (just like an induction coil creates an axial magnetic field inside it). The concept of topological field quantum generalizes also to the case of classical fields generated by wormholes.



**Figure 1:** Topological field quantization for magnetic field replaces flux lines with flux tubes having outer boundary as 3-surfaces.

In case of wormhole super conductivity “charge carriers” are wormholes. Wormhole looking like charge  $+Q$  on the “upper” sheet looks like charge  $-Q$  on the “lower” sheet; when looked from the wider perspective (embedding space), wormhole behaves as a dipole with extremely small dipole strength. The currents associated with wormholes are of opposite sign on the two space-time sheets and magnetic flux tube consists of two fluxes: the flux on the “upper” space-time sheet and return flux on the “lower” space-time sheet (see **Fig. 2**). Closed wormhole flux tube can be visualized as two circles above each other and having Planck distance; the circles carry opposite magnetic fluxes. This visualization turns out to be useful later.

### 3.2 Mind Like Space-Time Sheets

The original formulation of quantum TGD led to the conclusion that there are two kinds of space-time sheets: material space-time sheets and mind-like space-time sheets so that one can say that Matter Mind duality is realized in geometrical sense: of course, Mind is understood in the sense of cognitive representations only. What one means with mind like space sheets is however not at all obvious.

1. The original proposal was that mind like space-time sheets have by definition a finite temporal extension. In zero energy ontology this holds true for all space-time sheets so that all space-time sheets would be mind-like. This could make perfect sense. For instance, the fermionic



**Figure 2:** Artistic visualization of wormhole

part of zero energy state can be regarded as a logical rule  $A \rightarrow B$  with the instances of  $A$  and  $B$  represented as positive and negative energy fermion states in Fock basis: the Fock basis for many-fermion states indeed defines a representation of Boolean logic.

2. Mind like space-time sheets could be also interpreted as p-adic space-time sheets responsible for cognition whereas real space-time sheets would be matter like in the sense that they define the space-time correlates of sensory experience. The intersection of p-adic and real worlds is along rational and common algebraic points of the embedding space and is discrete (note that this statement assumes the identification of preferred embedding space coordinates). p-Adic space-time sheets could serve as natural correlates of cognition and intentionality and their interaction with real space-time sheets could give rise to effective p-adic topology crucial for the interpretation of p-adic mass calculations. p-Adic space-time sheets have infinite size in real topology so that cognition and intentionality could not be localized in brain. Only the cognitive representations defined by the intersections of real and p-adic space-time sheets allow this localization.
3. p-Adic space-time sheets can be mapped to real space-time sheets via a generalization of the canonical identification map which is continuous and maps rationals  $m/n$ ,  $m, n < p^k$ ,  $k > 0$ . to rationals. The explicit form of the map is  $m/n \rightarrow I_k(m)/I_k(n)$ , with  $I_k(m)$  defined as

$$x = \sum x_n p^{nk} \rightarrow \sum x_n p^{-nk} .$$

This map could define the effective p-adic topology for real space-time sheets in finite measurement resolution reducing to discretized real topology above distances defined by the p-adic length scale corresponding to  $p^k$ . Below the resolution length scale the impossibility to well-order p-adic numbers would correspond to the impossibility to order space-time points by physical measurements. What makes this map attractive is that it commutes with the discrete counterparts of various space-time symmetries in the resolution defined by  $p^k$  and is also continuous.

4. In zero energy ontology two scales emerges naturally. The scale of causal diamond comes as an octave of  $CP_2$  scale and corresponds to secondary p-adic length scale. The primary p-adic length scale characterizing elementary particles is essentially square root of this scale. In case of electron the latter scale is of order electron Compton length and the first one equals to .1 seconds defining the fundamental bio-rhythm. This suggests that MEs and magnetic flux tubes corresponding to secondary p-adic scale and having size of order CD size could be interpreted as mind-like space-time sheets. This interpretation will be adopted in the sequel.

### 3.3 Do Mind-Like Space-Time Sheets Perform Simple Mimicry?

Mind-like space-time sheets serve as quantum correlates of selves and are made possible by the classical non-determinism of the Kähler action and their defining property is finite temporal extension. Mind-like space-time sheets are absolutely crucial for TGD inspired theory of consciousness since their presence is what makes possible conscious experiences with contents localized in a finite time interval, which is characterized by the duration of the mind-like space-time sheet: without mind-like space-time sheets the contents of conscious experiences would not be temporally localized. Topological field quantization suggests the identification of the mind-like space-time sheets as classical counterparts of virtual particles, in particular, virtual photons. This suggests that some (not all) mind-like space-time sheets could be topological correlates of the internal (photon) lines of Feynman diagram and thus have naturally finite time duration.

Rather remarkably, TGD based notion of energy correlates the sign of energy with time orientation and allows mind-like space-time sheets to have also negative energy. Also wormhole-magnetic fields could be analogous to virtual particle pairs with vanishing total energy if the space-time sheets associated with the wormhole magnetic field have opposite time orientation. Mind-like space-time sheets provide cognitive representations and the simplest representation is direct mimicry. Hence one cannot exclude the possibility that wormhole magnetic fields form cognitive representations of the surrounding world in an extremely concrete manner: the magnetic field strength is the same as the field strength of the “real” magnetic field. This could hold true quite generally: pairs of space-time sheets with opposite time orientation could form cognitive representations of the external world such that the field strengths are same as those of the external world.

A concrete manner to achieve this mimicry is to glue mind-like space-time sheet pairs on the boundaries of the material space-time sheets by connecting the material space-time sheet by join along boundaries bond to the mind-like space-time sheet with a positive time orientation. This would mean that universe would be mimicking itself at classical level and in very concrete manner: note that this mimicry would resemble the emulation of Turing machines performed by Turing machines. In particular, the effect of em radiation on living matter at cyclotron frequencies of ions in Earth’s magnetic field (or modulated by these frequencies) [J2] could be due to the fact that some ions “drop” (or rather, flow along join along boundaries bonds/flux tubes) to the space-time sheets of wormhole magnetic fields providing cognitive representation for Earth’s magnetic field.

An interesting possibility is that cell membranes correspond to  $Z^0$  wormhole magnetic fields glued to the boundaries of the cellular space-time sheets, or rather, are between and glued to the boundaries of cellular and extracellular space-time sheets characterized by same p-adic prime. The model for hearing and cognition is consistent with but does not require this assumption [K13, K14, K24].

This view reflects my thinking for more than decade ago. In particular, the notion of mind-like space-time sheet is based on the observation that determinism in its standard form fails and the idea that one can save determinism by allowing 3-surfaces consisting of union of disjoint space-time sheets with time-like separations. In zero energy ontology providing a more rigorous formulation for the generalized notion of classical determinism causal diamonds (CDs) defined as intersections of future and past directed light-cones play a key role. Space-time sheets connect the two light-like boundaries of CDs carrying opposite net quantum numbers. Mind-like space-time sheets could be identified as to space-time sheets associated with sub-CDs and would be analogous to radiative corrections in quantum field theory picture. One can of course argue that all space-time sheets are mind-like in this framework. For instance, the fermionic oscillator operators at the ends of space-time sheet provide a representation of Boolean algebra and zero energy states could be interpreted as Boolean statements of type A implies B.

One should not confuse mind-like space-time sheets with cognitive space-time sheets identified as p-adic counterparts of space-time sheets and having literally infinite size in real sense and a discrete intersection with real space-time sheets consisting of rational points and points in some algebraic extension of rationals.

### 3.4 Model For Wormhole Flux Tube As A Hollow Cylinder

In the absence of ordinary matter the electric part of gauge field is sourceless in the interior of the flux tube and one must assume the geometry of a *hollow cylinder* for the flux tube to avoid



singularities. The wormhole charge densities on the inner and outer boundaries of the cylinder are of opposite sign and sourceless radial electric field is created in the interior of the cylinder. Rotational motion of the wormholes creates axial magnetic fluxes of opposite sign on the two space-time sheets. Clearly, the magnetic flux runs along the cylinder; goes to “lower” space-time sheet via magnetic wormhole, and returns along the “lower” space-time sheet. It is perhaps needless to add that hollow cylindrical structures are very frequent in bio-systems: representative examples are provided by microtubules and axons.

### 3.5 Wormhole Flux Tubes Need Not Be Closed In Ordinary Sense

The wormhole flux tube can apparently have an end unlike ordinary magnetic flux tube. At the end point the magnetic flux from the “upper” sheet flows to the “lower” sheet through *magnetic* wormhole, which looks like a magnetic monopole, when viewed from either sheet of 3-space. From embedding space perspective, one has extremely weak magnetic dipole, with monopoles located at Planck distance. Note that magnetic flux lines are closed as they should be.

The simplest expectation is that also wormhole flux tubes run along the closed field lines of the average classical magnetic field associated with the wormhole flux tube configuration. Wormhole flux tube structures can however form topologically much more complicated structures since one can construct also branched flux tubes by gluing two flux tubes together such that contact point contains magnetic wormhole.

### 3.6 Wormhole Flux Tubes Form A Macroscopic Quantum System

Since wormholes populate the boundaries of the flux tubes and since they form BE condensate, the entire exotic magnetic field configuration can be regarded as a macroscopic quantum system. Thus, according to TGD inspired theory of consciousness, flux tube configurations should be indeed controllable by quantum jumps and quantum mechanical free will becomes possible in the entire region covered by the exotic magnetic field configuration. One might even say, that wormhole condensate makes classical field a potential conscious being. This suggests that wormhole magnetic fields are crucial for the understanding the behavior of bio-systems as systems possessing free will.

The simplest possibility is that only the fluxes of the magnetic fluxes inside flux tubes are controlled by free will. As a consequence, psychokinetic effects on objects, which are wormhole super conductors, are in principle possible via a voluntary control of Meissner force (levitation). As found in [K15], magnetic fluxes associated with flux tubes are in general quantized so that control occurs in discrete steps.

### 3.7 The Interaction Of Coherent Light With Wormhole Flux Tubes

To understand Comorosan effect and phantom DNA effect to be considered in next section, one must construct a model for the interaction of wormholes with laser light. Needless to say, this interaction is fundamental for the TGD based description of bio-systems as macroscopic quantum systems.

1. Wormholes have coupling to the *difference*  $\Delta A$  of the quantized gauge potentials describing photons (Planck size 3-surfaces) of topologically condensed coherent light on the two space-time sheets of the wormhole flux tube. This is due to the fact that wormhole behaves as a pair of two opposite charges on the two parallel space-time sheets connected by it.
2. The absorption of laser light can induce topology change for a closed wormhole flux tube. It is useful to visualize wormhole flux tubes as two one-dimensional closed circles above each other (within distance of Planck length). Clearly, the circles span in the initial situation *annulus*. The absorption of laser light can induce a pinching process in which the two circles are deformed so that they touch each other momentarily. At the moment of touching the circles are cut and the ends can recombine in two different ways to form a single circle. Either the upper and lower ends of circle on the same side recombine to give single circle which spans *annulus with cut*. Or the upper and lower ends belonging to different sides recombine to form a circle with a twist of  $\pi$ , which spans a *twisted annulus*, known as Möbius strip, which is

non-orientable, single-sided surface. The model for Comorosan and phantom DNA effects relies on the process *annulus*  $\rightarrow$  *twisted annulus*.

### 3.8 Quantum Antenna Hypothesis And Wormholes

Quantum antenna hypothesis states that microtubules create a coherent state of photons (in particular bio-photons) and possibly also of gravitons. If the proposed model for the interaction between wormholes and coherent light is correct, then the presence of quantum coherent light in bio-system is necessary for the generation of currents in wormhole flux tube structures associated with DNA.

These currents correspond to phase gradients and the integer valued quantum numbers characterizing the phase increments around closed loops have been proposed to provide a coding of biological information and a model of memory [K7]. Although the model was constructed assuming that bio-system is ordinary super conductor, it works also for wormhole super conductor option. Note also, that the previous model fixes also the interaction between coherent photons and wormholes associated with the lipid layers of cell membrane, which is only one example of hollow cylinder like configurations frequent in bio-systems. An interesting possibility is that bio-system uses the twisted and untwisted configurations of closed flux tubes to store binary data.

Combining these ideas with the suggested identification for the quantum correlates of the sensory qualia, a definite picture of bio-system as a macroscopic quantum in which both wormholes and wormhole magnetic fields, coherent light electronic and neutrino Cooper pairs have essential roles, seems to emerge. [To be honest, this is actually quite an old discovery: the basic concepts of Hindu yoga are prana channels (wormhole flux tubes) and light (coherent photons)!].

### 3.9 Phantom DNA Effect, Comorosan Effect, DNA As A Conductor, ORMEs: Four Peculiar Effects With A Common Explanation

The concept of closed wormhole flux tube provides explanation for Comorosan effect and phantom DNA effect as also the conductivity of DNA [D1] described in [K5, K6]. The irradiation of bio-matter using visible laser light with certain preferred frequencies is crucial for *all* these effects. The interpretation is that irradiation transfers electron from one space-time sheet to another one (and creates automatically wormhole) and since the energy of electron is quantized, the preferred frequencies correspond to energy differences of electron on the two space-time sheets associated with the wormhole flux tube. This in turn provides support for the exotic atom concept providing explanation for the properties of ORMEs [H3].

## 4 Comorosan Effect, Phantom DNA Effect And Homeopathy

### 4.1 Comorosan Effect

The first model for Comorosan effect was based on super conductivity and the formation of Josephson junctions between interacting organic molecules assumed to contain closed super conducting current loops. The model reproduced the basic formula of Comorosan effect but *not all* aspects related to the interaction of laser light with organic molecule were understood. Wormhole super conductivity leads to much more precise model for this interaction and wormhole super conductivity is strongly favored over ordinary the super conductivity as an explanation of the effect.

#### 4.1.1 The effect

Comorosan effect [I6, I2] demonstrates rather peculiar looking facts about the interaction of organic molecules with visible laser light at wavelength  $\lambda = 546 \text{ nm}$ . As a result of irradiation molecules seem to undergo a transition  $S \rightarrow S^*$ .  $S^*$  state has anomalously long lifetime and stability in solution.  $S \rightarrow S^*$  transition has been detected through the interaction of  $S^*$  molecules with different biological macromolecules, like enzymes and cellular receptors.

The typical result in the enzyme-substrate interaction is represented by the enhancement of the enzymic rate, when the respective enzyme substrate is previously irradiated for certain sharply

defined times. These *efficient (irradiation) times* are enzyme dependent and can also depend on the biological origin of the enzyme. They are always of the following type  $t_i = i * 5$  sec, where  $i$  is certain integer. The general formula for the effective times is  $t_k = t_m + (k - 1)\tau_n$ ,  $k = 1, 2, \dots, 6$ , where  $t_m$  is the minimum radiation time inducing the first effect and  $\tau_n$  is the period between two consecutive effects [I6, I2].  $t_m = m_E t_1$  and  $\tau_n = n_E t_1$  are multiples of the basic time scale  $t_1 = 5$  sec:  $t_k = (m_E + (k - 1)n_E)t_1$ . The integers  $m_E$  and  $n_E$  can be regarded as enzyme characteristics, depending however on the biological origin of the enzyme.

Consider the specific enzymic interaction  $E + S \leftrightarrow ES \leftrightarrow E + P$ , where E stands for enzyme, S for substrate and P interaction product. Assume that substrate S is subject to a sequence of distinct irradiations lasting for times  $t_a, t_b, \dots$ . The following rules are found to hold true.

- 1) The irradiations of the substrate performed after an irradiation with efficient time have no effect on the enzyme-substrate interaction.
- 2) Any arbitrary irradiation of the substrate with irradiation time less than sixth efficient time  $t_6$  performed prior to any other efficient time, is irrelevant for the enzyme-substrate interaction.
- 3) Any arbitrary irradiation of the substrate lasting more than the sixth efficient time  $t_6$  and performed prior to an efficient time precludes all other subsequent effects in enzyme-substrate interaction.

The work of Comorosan demonstrates that all irradiation times have nontrivial effect on organic molecules but that for effective times something very special must occur. One must understand what this “very special” is, derive Comorosan formula from a physical model and find physical interpretation for the integers  $m_E$  and  $n_E$  appearing in the formula as well as explain the special role of  $t > t_6$  irradiation times.

#### 4.1.2 Model for the interaction of laser light with organic molecule

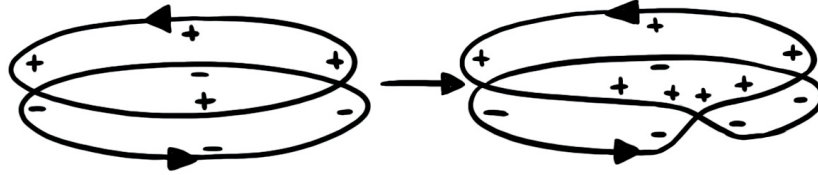
The model reproduces the basic formula of Comorosan effect but there were also some not so well understood aspects.

1. Effect occurs for *preferred frequencies* only. This can be understood if the process the interaction of laser light with wormhole flux tube involves transfer of electron from one condensate level to another one and thus a change of energy level. The transfer of electron leads to a creation of a wormhole.
2. The *intensity of laser light does not matter*. What is needed is that the intensity is above certain threshold. The original explanation in terms of saturation of effect (for large intensities of laser light the effect of laser light on organic molecules does not depend on the intensity) has turned to be unsatisfactory. It seems that laser light just initiates some process which itself does not depend on the laser light.
3. The assumption that laser light stimulates the increase of a phase angle increment type variable defined over a loop, which is effectively cut in process, explains the preferred radiation times. What happens is that the phase increment increases linearly with time and for preferred radiation times the increase of phase angle is multiple of  $2\pi$  so that the loop can close back again. The experience with super conductivity suggests the identification of the phase angle gradient as quantized momentum: the problem is to identify the carrier of this momentum.

An elegant explanation for these aspects of Comorosan effect results if one assumes that wormhole super conductivity is in question and that laser light induces a transformation of a closed wormhole tube spanning an *annulus* to that spanning a *twisted annulus*. Since the characteristic time scale is defined by the frequency of laser light, the process in question occurs very rapidly as compared to the time scale of order 5 seconds of the laser irradiation. What is important is that the reverse process in which a twisted annulus transforms to an untwisted annulus cannot occur if the wormholes possess momentum  $k$  which is not multiple of  $2\pi/L$  (by the quantization of momentum propagating in closed loop) and the wave length of laser length is large compared to the size of the loop.

The twisted annulus configuration leads to the acceleration of the wormholes and generation of longitudinal wormholes currents. If the initial, annulus type configuration of the flux tube contains constant wormhole charge density, then for the twisted annulus the charge density is of constant

magnitude and of opposite sign on the different sides of each kink since the twist interchanges the “upper” and “lower” space-time sheets. Half of the structure corresponds to positive, and half of the structure to negative wormhole charge density (see **Fig. ??** ).



**Figure 3:** The interaction with laser light is assumed to induce the transformation of annulus configuration of wormhole flux tube to twisted annulus and creation of at least one wormhole pair with opposite charges. The members of wormhole pair go to separate kinks and create small longitudinal electric field.

One must assume that both kinks contain *additional wormhole charges of opposite sign* generated from vacuum, when the twisted annulus configuration is created in the interaction with the laser light. The creation of a twisted annulus is necessary in order to get a pair of opposite charges with large distance along the flux tube. These wormhole charges serve as sources of additional electric fields. Most of the electric flux flows in the radial direction of the flux tube but a small fraction  $E_L = \epsilon E_{max}$  of the maximal flux  $E_{max} = e/2S$ , where  $S$  is the transverse area of the tube, is assumed to flow along the flux tube surface.  $E_L$  has constant magnitude and is of opposite sign on the “upper” and “lower” space-time sheets.

$E_L$  accelerates the wormholes. The acceleration is of opposite sign at the opposite sides of the kinks and leads to the flow of the wormholes to the kink, where they must annihilate topologically. Newton’s equation for the wormhole in external field gives wormhole momentum  $k(t)$  as a function of time

$$\begin{aligned} \frac{dk}{dt} &= \epsilon 2eE , \\ E &= \frac{e}{2S} \text{sign}(x) . \\ \text{sign}(x) &= \begin{cases} -1, & x < 0 , \\ +1, & x > 0 \end{cases} \end{aligned} \quad (4.1)$$

Here  $|x|$  measures the distance from the twist. The factor 2 in Coulomb force comes from the identical contributions of the two space-time sheets to the Coulomb force. The momentum of wormhole as function of time can also be obtained from the quantization condition

$$k - 2eA_L = 0 , \quad (4.2)$$

stating that wormhole order parameter is covariantly constant in the longitudinal direction. Since  $A_L = E_L t$  holds true, one obtains same result as from Newton’s equation.

Wormhole momentum increases linearly as a function of time since constant force is in question apart from the effect caused by the gradually decreasing density of wormholes caused by wormhole pair annihilation in kinks; this effect is however completely negligible since the time scale is so slow. In an excellent approximation the momentum gained by the wormholes in time  $t$  is

$$\begin{aligned}
k(t) &= \epsilon \frac{e^2}{S} t = \frac{2\pi}{L} \frac{t}{t_0} , \\
t_0 &= \frac{1}{\alpha} \frac{1}{2\epsilon} \frac{S}{L} , \\
\alpha &= \frac{e^2}{4\pi} .
\end{aligned} \tag{4.3}$$

Here  $t_0$  is the time during which  $k$  achieves a value allowing the transitions back to the untwisted flux tube configuration. In agreement with the experimental data, the time scale  $t_0$  does not depend on the intensity of irradiation;  $t_0$  should be of the order of 5 seconds.  $L$  should be considerably smaller than the wavelength of the visible light in case of Comorosan effect. For  $\sqrt{S}$  and  $L$  of order  $10^{-9}$  and  $10^{-8}$  meters respectively one obtains the estimate  $\epsilon \sim 10^{-16}$  so that the longitudinal fraction of electric gauge flux is extremely small.

For  $t = t_n = nt_0$  wormholes have gained momentum  $k = n2\pi/L$ , for which the return to the ordinary closed untwisted flux tube configuration is possible. Laser light stimulates automatically transitions to the untwisted configuration. If laser light stimulation is not continued after  $t_n$ , a certain fraction of molecules is left to the closed untwisted loop state with wormhole momentum  $k = n2\pi/L$ . It is the presence of these loops carrying wormhole super current, which explains the change in the interactions of with organic molecules if interaction involves the formation of Josephson junctions between interacting molecules. If the stimulation is continued, also the closed untwisted loops suffer a re-transition to the twisted state and the momentum  $k$  continues to increase and the effect remains small. If stimulation ceases at such moment of time that  $k$  fails badly to satisfy the quantization condition the loops remain in twisted configuration and transitions to untwisted configuration are rare.

#### 4.1.3 The explanation for Comorosan formula

It is assumed that organic molecules are wormhole super conductors containing closed wormhole flux tubes. The explanation as such does not differentiate between ordinary and wormhole super conductors.

If wormhole order parameter is proportional to a spatially non-constant phase factor then the flux tubes of the wormhole magnetic field carry longitudinal wormhole supra currents proportional to the gradient of the phase factor. The increment of the phase factor around any closed loop is  $n2\pi$ ,  $n$  integer, and the momentum associated with the wormhole is proportional to  $n$ . These supra currents are created with the interaction of the wormhole flux tubes with laser light by a mechanism already considered.

Assume that enzyme contains a loop carrying wormhole supra current characterized by an enzyme specific integer  $m_E$  and created by the previously described interaction with the laser light. Assume that the substrate contains a similar loop, characterized by integer  $n_S$ . Assume further that in the enzyme-substrate interaction  $n_E$  Josephson junctions between the identical loops are formed and that the Josephson junctions are evenly spaced in  $\Phi$  and there are either  $n_E = 2s + 1$  or  $n_E = 2s$  junctions corresponding to ODD and EVEN receptors defined by Comorosan [12]. Assume that the directions of the wormhole supra currents are same. The phase difference between the ends of the Josephson junction gives phase factor  $\exp(i(N_E - N_S)\Phi_n)$  to the current flowing through  $n$ :th junction and destructive interference in general occurs for the sum of Josephson currents. If the junctions are identical Josephson current is proportional to quantity  $U$  defined as a sum of phase factors

$$\begin{aligned}
U &= \sum_{k=0, \dots, n_E} \exp\left((m_E - n_S) \frac{i2\pi}{n_E}\right) \\
n_E &= 2s + 1 \text{ (ODD receptor)} \\
n_E &= 2s \text{ (EVEN receptor)}
\end{aligned} \tag{4.4}$$

All phase factors are trivial and constructive interference occurs, when the condition

$$n_S = m_E + (k - 1)n_E, \quad k = 1, 2, \dots \quad (4.5)$$

is satisfied. This is just the condition for Comorosan effect to occur. Therefore, if the occurrence of constructive interference leads to enhanced enzymatic effect, that is “reading” of the substrate state in terminology of Comorosan, the model reproduces the experimental results of Comorosan for  $k \leq 6$  and gives interpretation for  $m_E$  as angular momentum like quantum number associated with super current and  $n_E$  as the number of Josephson junctions.

Note that Comorosan defines UP-type receptors as a receptor which read only ODD states with  $t_k$  odd multiple of  $t_1$  [I2]. These correspond to odd value of  $m_E$  and even value of  $n_E$ . DOWN-type receptors read only DOWN-type states with  $t_k$  even multiple of  $t_1$ : these correspond to even values of  $m_E$  and  $n_E$ . UP-DOWN receptors correspond to odd values of  $m_E$  and  $n_E$ .

The model reproduces the basic experimental regularity observed by Comorosan with single exception. Comorosan has observed no effect for  $t_{rad} > t_6$ : according to the model the effect should be observed for all odd values of  $k$  and depend on  $k_1 = k \bmod n_E$  only so that  $k$  and  $k + n_E$  ought to lead to same effect. The problem looks difficult since  $t_6$  is enzyme dependent parameter. The only manner to explain this observation seems to be following. Assume that substrate contains several loops  $L_i$ , one loop for each enzyme type  $E_i$  studied and that each loop is radiation detector in the sense already described. Assume that  $E_i$ -loop ceases to respond to irradiation, when the value of  $\Delta\Phi$  exceeds the critical limit corresponding to  $n_{cr}(E) = m_E + 5n_E$ . One explanation for this behavior is that the supra current exceeds critical value and wormhole super conductivity is lost. The shorter the loop the smaller the critical value of  $n_{cr}(E)$  is expected to be.

This model suggest that organic molecules are able to store memories into the integer valued vacuum quantum numbers associated with their supra current loops and that the interaction with coherent light, bio-photons perhaps, provides a mechanism of memory storage. The enzyme-substrate interactions in turn code this information to chemical form.

#### 4.1.4 What is the origin of the 5 second time scale?

The time scale  $\tau = 5$  seconds associated with the Comorosan effect has remained a teasing mystery for almost a decade. In particular, p-adic length scale hypothesis does not explain the time scale, and it does not correspond to any obvious time scale associated with magnetic transitions.

Only the model for quantum dark matter [K27] inspired by the fascinating findings that planetary orbits obey Bohr rules analogous to those for hydrogen atom but with a huge value of Planck constant equal to  $\hbar_{gr} = GMm\hbar/v$ , where  $v/c$  is a harmonic or sub-harmonic of  $v_0/c = 4.8233 \times 10^{-4}$ , led to a progress in the understanding of the time scale  $\tau$ .

The idea about astro-quantal dark matter as a fundamental bio-controller by its gigantic value of Planck constant, inspires the guess that  $\tau$  could relate to a quantal dark matter structure topologically condensed around a magnetic flux tube around a planetary Bohr orbit of radius  $R$  via the correspondence  $\tau = R/c$ . As observed by [E2],  $n = 1$  orbit for  $v_0 \rightarrow 3v_0$  corresponds in a good approximation to the solar radius  $R_1 = AU/(9 \times 25) = R_S$  and thus to a time scale of 2.18 seconds. Since Earth’s orbit corresponds to the principal quantum number  $n = 5$ ,  $n = 1$  orbit corresponds for  $v_0 \rightarrow 2v_0$  to Bohr radius  $R_1 = AU/4 \times 25 = (9/4)R_S$  and  $\tau = AU/(4 \times 25) = 4.992$  seconds ( $c = 1$ ): here  $R = AU$  is the astronomical unit equal to the average distance of Earth from Sun.  $R$  corresponds approximately to the radius of solar core. The deviation from  $\tau_C$  is only one per cent and of the same order of magnitude as the variation of the radius for the orbit due to orbital eccentricity  $(a - b)/a = .0167$ . [E1].

One could argue that  $v_0 \rightarrow 2v_0$  is artificial trick unless one can assign it to the analog of  $n = 1$  Bohr orbit with radius smaller than solar radius.  $v_0$  would give for the orbit of  $n = 1$  radius  $R = AU/25$  roughly equal to and  $\tau = 20$  s.  $\tau = 5$  seconds could be interpreted in terms of 4:th harmonic in this case

An alternative explanation emerged with the discovery of dark matter hierarchy based on the scaled up values of  $M^4$  and  $CP_2$  Planck constants given as  $\hbar(M^4) = n_a \hbar_0$  and  $\hbar(CP_2) = n_a \hbar_0$ ,  $n_i > 2$  [K12]. Typical quantum times and lengths, say Compton length and time, scale as  $n_a$ . The integers  $n_i$  have number theoretically preferred values which correspond to n-polygons constructible using only ruler and compass. These integers are given as  $n = 2^k \prod_s F_s$ , where each Fermat prime  $F_s$  can appear only once in the product.  $F_s$  has the form  $F_s = 2^{2^s} + 1$ . The known Fermat primes

are 3, 5, 17, 257, and  $2^{16} + 1$ . If one scales the fundamental biological time scale  $T_2(127 = .1 \text{ s})$  by  $n_F = 3 \times 17$  one obtains the time scale  $T = 5.1 \text{ s}$ .

## 4.2 Phantom DNA Effect

The phenomenon of phantom DNA [14, 18] suggests that physical vacuum can have some additional structure with no obvious identification in the standard physics context. What is studied, is the scattering of the laser light on chamber, which is either empty or contains DNA. The autocorrelation function for scattered laser light is measured. This means in practise a linear array of detectors, which measure the number of scattered photons during certain time interval. There are three subsequent stages in the experiment.

1. Scattering chamber is empty. In this case autocorrelation function is random. The numbers of photons detected by various detectors are essentially random.
2. One adds the DNA in the chamber and finds that autocorrelation function is decaying exponential, which oscillates. This is due to the scattering of laser light on DNA.
3. One removes the DNA and instead of random autocorrelation finds that autocorrelation function exhibits exponential decay and oscillations also now! The numbers of photons detected are many orders of magnitude smaller but it is clear that something in the structure of vacuum, call it *phantom DNA*, serves as an effective scatterer of the laser light. For phantom DNA effect to occur it is essential that DNA in chamber is illuminated with laser light before its removal. The effect is long lasting, phantom DNA is detected even after period of months!

### 4.2.1 Is the mechanism explaining Comorosan effect behind phantom DNA effect?

The mechanism explaining Comorosan effect could explain also phantom DNA effect. Assume that the presence of DNA creates wormhole magnetic field, that is a net of wormhole flux tubes. This configuration is indeed vacuum configuration from the point of view of standard physics since the only “particles” are wormholes on the boundaries of the flux tubes. Laser light transforms closed untwisted flux tubes to twisted ones and accelerates wormholes so that they get net momentum.

When DNA is removed from the chamber, part of the wormhole magnetic field remains in chamber. If the chamber is now irradiated with laser light, the *wormhole supra currents* created in the irradiation of DNA interact with the laser light. Before the irradiation these currents vanish so that there is no effect. More quantitative argument goes as follows. Coupling is just the standard coupling of charged scalar field to the difference of topologically condensed coherent photon fields so that the interaction term is of the general form  $\bar{\Psi}\Delta A\nabla\Psi$ . In Fourier basis the couplings are of the form  $e(k_i + k_f)A(k_i - k_f)$ . If  $A$  is slowly varying, one has in good approximation  $k_i = k_f$  for the allowed transitions, and transition matrix element is proportional to  $k$ . Thus the value of momentum  $k$  and thus coupling is appreciable *only* if DNA is irradiated before its removal.

The transfer of electron between the space-time sheets must be *crucial* for the process acceleration process. Otherwise, the irradiation of mere wormhole flux tube structure, “phantom DNA”, would accelerate the wormholes creating supra currents and would eventually lead to stimulated emission.

### 4.2.2 Other explanations

With the development of the model for the bio-system as a macroscopic quantum system are also other possible explanations of the phantom DNA effect have emerged.

1. Perhaps the simplest explanation would be that a small fraction of DNA molecules drops to the magnetic flux tubes of Earth’s magnetic field and scatters the coherent light.
2. The hypothesis that liquid crystal water blobs can mimic the electromagnetic body of the DNA molecule in the sense that some parts of the electromagnetic spectrum represented by MEs are more or less identical with that of DNA, could explain the phantom DNA effect in terms of the liquid crystal blobs remaining when DNA is removed. The explanation would

be same as for the effect of the homeopathic remedies. The explanation requires that LC water blobs are able to mimic the electromagnetic spectrum of DNA at visible frequencies. This is not at all obvious since water is transparent for visible light and thus does not have intense spectral lines in the visible frequency range.

### 4.3 Mind-Like Space-Time Sheets, Mimicry And Homeopathy

Homeopathy resembles phantom DNA effect in the sense that the repeated dilution of some drugs seems to give rise to a concentration of a “phantom drug” affecting the patient in some non-chemical manner. Standard science refuses to take homeopathy seriously. As often is the case with the paranormal phenomena, the refusal is based on very simple argument: standard science does not allow this kind of effect. TGD however framework allows room for homeopathy and homeopathy provides evidence for the notion of mind-like space-time sheet absolutely crucial for TGD based theory of consciousness as also for the general hypothesis that magnetic and  $Z^0$  transition frequencies are quantum correlates of consciousness.

In TGD inspired theory of consciousness mind-like space-time sheets, which by definition have finite time duration, are geometric correlates of selves. TGD inspired theory of consciousness predicts that self hierarchy starts already from the elementary particle level and that the typical duration of self is given by the p-adic time scale  $T_p = l \times L_p/c$ ,  $l \simeq 10^4$  Planck lengths. For elementary particle selves the duration of wake-up time is of order Compton time and extremely short in human standards but extremely long when using the average duration of single quantum jump of order  $l/c$  as standard: elementary particle performs roughly  $\sqrt{p}$  quantum jumps during its wake-up period and the values of p-adic prime are huge (electron has  $p = 2^{127} - 1$ ).

If this scenario is correct, mind-like space-time sheets should accompany all forms of matter. Against this background it would not be too surprising that given drug would be characterized, not only by its chemistry, but also by the mind-like space-time sheets associated with its sub-selves. When the drug is dissolved into water, it can happen that mind-like space-time sheets associated with the drug lose their original owner and become (potential) sub-selves of the solvent. If this really happens, a concentration of mind-like space-time sheets associated with the “drug selves”, remains into the solution, even when the drug is diluted to practically zero concentration. Water need not be a mere passive receiver of the mind-like space-time sheets of the drug but can also generate new mind-like space-time sheets mimicking the mind-like space-time sheets of drug. The effect of the drug on living organism involves self-organization and therefore also consciousness at some level. Thus it would not be surprising if “drug selves” were the effective component of some drugs and that the chemistry would only determine what “drug selves” and their effects are. This is indeed expected, since mind-like space-time sheets provide cognitive representations for the properties of the material space-time sheets associated with the drug.

One can imagine several options for how mind-like space-time sheets represent the relevant properties of drug. If cognitive space-time sheets perform direct mimicry of the material space-time sheets this scenario becomes even more plausible since mind-like space-time sheet and drug space-time sheets would not differ much in their electromagnetic properties. For instance, disease could involve the inability of some sub-selves of the organism to stay awake and self-organize: brisk new drug selves could simply replace these sleepish sub-selves and initiate the self-organization processes again! Note that direct mimicry might be involved also with the phantom DNA effect. The wormhole magnetic fields (or massless extremals) associated with DNA could mimic the classical fields associated with DNA molecule. TGD based concept of space-time allows in principle non-vanishing vacuum currents so that also the smoothed out charge distribution of DNA might be mimicked. If this indeed occurs, the interaction of the coherent light with DNA could resemble to some degree to its interaction with real DNA.

“Direct mimicry” understood as a generation of a copy about classical fields associated with the material space-time sheet (note that the sheet is 4-dimensional!) might be too strong a requirement. A more abstract mimicry is restricted on regeneration of dominating frequencies associated with the classical fields: this could be enough since it is resonance frequencies rather than amplitudes which are crucial for quantum control and coordination. The effects of ELF modulated em fields on living matter [J2] suggest that also amplitude modulation could be involved with the formation of the cognitive representations. mind-like space-time sheets associated with water could simply mimic the drug in frequency domain by reproducing the frequencies generated by the drug molecules



or corresponding mind-like space-time sheets. That this might be the case is supported by the following arguments.

1. There are well documented effects related to the ability of water to absorb and transmit frequencies [J3]. The ability of water to absorb and transmit frequencies could rely on the generation of mind-like space-time sheets oscillating with the same frequency as stimulus. Water would form cognitive representation for the stimulus, mimic it.
2. The hypothesis that magnetic and  $Z^0$  magnetic transitions frequencies are basic correlates of consciousness [K13] suggests that the effects of at least some drugs are quantum control effects and basically frequency mediated and that chemical effects are only secondary. If the effect of a drug indeed relies on its ability to generate an oscillation (say ELF em field) with some frequency and if this oscillation is generated by mind-like space-time sheets associated with water, then the mechanism of homeopathy could be understood.

Rather interestingly, subject persons allergic to a particular substance exposed to the substance and frequency at the same time develop after a short association period an allergic response to the frequency alone [J3]. A patient who has developed allergic response to certain frequency has also allergic response to water treated by the same frequency. Thus the water in human body together with central nervous system seems to have cognitive abilities, in particular ability to form associations. This suggests the possibility of associative medicine: the effect of drug is conditioned with frequency: in this manner the undesired side effects of the chemical drug could be circumvented.

#### 4.4 Clustering of RNA polymerase molecules and Comorosan effect

Once again I had good luck: I received a link (see <http://tinyurl.com/y7bego83>) to a highly interesting popular article telling about the work by Ibrahim Cisse at MIT and his colleagues [I3] (see <http://tinyurl.com/y9wzt5y1>) about the clustering of RNA polymerase proteins in the transcription of RNA. Similar clustering has been observed already earlier and interpreted as a phase separation giving rise to protein droplets [L6]. Now this interpretation is not proposed by experiments but they say that it is quite possible but they cannot prove it.

I have already earlier discussed the coalescence of proteins into droplets as this kind of process in TGD framework [?] [L6]. The basic TGD based idea is that proteins - and biomolecules in general - are connected by flux tubes characterized by the value of Planck constant  $h_{eff} = n \times h_0$  for the dark particles at the flux tube. The higher the value of  $n$  is the larger the energy of given state. For instance, the binding energies of atoms decrease like  $1/n^2$ . Therefore the formation of the molecular cluster liberates energy usable as metabolic energy.

**Remark:**  $h_0$  is the minimal value of  $h_{eff}$ . The best guess is that ordinary Planck constant equals to  $h = 6h_0$  [L2, L5] (see <http://tinyurl.com/goruuzm> and <http://tinyurl.com/y9jxyjns>).

##### 4.4.1 TGD view about the findings

Gene control switches - such as RNA II polymerases in DNA transcription to RNA - are found to form clusters called super-enhancers. Also so called Mediator proteins form clusters. In both cases the number of members is in the range 200-400. The clusters are stable but individual molecules spend very brief time in them. Clusters have average lifetime of  $5.1 \pm .4$  seconds.

Why the clustering should take place? Why large number of these proteins are present although single one would be enough in the standard picture. In TGD framework one can imagine several explanations. One can imagine at least following reasons.

1. If the initiation of transcription is quantum process involving state function reduction, clustering could allow to make this process deterministic at the level of single gene in spite of the non-determinism of state function reduction. Suppose that the initiation of transcription is one particular outcome of state function reduction. If there is only single RNA II polymerase able to make only single trial, the changes to initiate the transcription are low. This could be the case if the protein provides metabolic energy to initiate the process and

becomes too “tired” to try again immediately. In nerve pulse transmission there is analogous situation: after the passing of the nerve pulse generation the neuron has dead time period. As a matter of fact, it turns out that the analogy could be much deeper.

How to achieve the initiation with certainty in this kind of situation? Suppose that the other outcomes do not affect the situation appreciably. If one particular RNA polymerase fails to initiate it, the others can try. If the number of RNA transcriptase molecule is large enough, the transcription is bound to begin eventually! This is much like in fairy tales about princess and suitors trying to kill the dragon to get the hand of princess. Eventually comes the penniless swineherd.

2. If the initiation of transcription requires large amount of metabolic energy then only some minimal number of  $N$  of RNA II polymerase molecules might be able to provide it collectively. The collective formed by  $N$  molecules could correspond to a formation of magnetic body (MB) with a large value of  $h_{eff} = n \times h_0$  and controlling the molecules and inducing its coherent behavior. The molecules would be connected by magnetic flux tubes.
3. If the rate for occurrence is determined by an amplitude which is superposition of amplitudes assignable to individual proteins the rate is proportional to  $N^2$ ,  $N$  the number of RNA II polymerase molecules. The process for the cluster is reported to be surprisingly fast as compared to the expectations - something like 20 seconds. The earlier studies have suggests that single RNA polymerase stays at the DNA for minutes to hours.

Clustering could allow to speed up bio-catalysis besides the mechanism allowing to find molecules to find by a reduction of  $h_{eff}/h = n$  for the bonds connecting the reactants and the associated liberation of metabolic energy allowing to kick the reactants over the potential wall hindering the reaction.

Concerning the process of clustering there are two alternative options both relying on the model of liquid phase explaining Maxwell’s rule assuming the presence of flux tube bonds in liquid and of water explaining its numerous anomalies in terms of flux tubes which can be also dark (see <http://tinyurl.com/ydhknc2c>).

1. **Option I:** Molecules could form in the initial situation a phase analogous to vapour phase and there would be very few flux tube bonds between them. The phase transition would create liquid phase as flux tube loops assignable to molecules would reconnect form flux tube pairs connecting the molecules to a tensor network giving rise to quantum liquid phase. The larger then value of  $n$ , the longer the bonds between molecules would be. This kind of model [?] (see <http://tinyurl.com/yassnhzb>) is used to explain the strange findings that a system consisting of plastic balls seems to show primitive features of life such as metabolism.
2. **Option II:** The molecules are in the initial state connected by flux tubes and form a kind of liquid phase and the clustering reduces the value of  $h_{eff}/h = n$  and therefore the lengths of flux tubes. This would liberate dark energy as metabolic energy going to the initiation of the transcription. One could indeed argue that connectedness in the initial state with large enough value of  $n$  is necessary since the protein cluster must have high enough “IQ” to perform intelligent intentional actions.

Protein blobs are said to be drawn together by the “floppy” bits (pieces) of intrinsically disordered proteins. What could this mean in the proposed picture? Disorder would mean absence of correlations between building bricks of floppy parts of the proteins in translational degrees of freedom.

1. Could floppiness correspond to low string tension assignable to long flux loops with large  $n$  assignable to the building bricks of “floppy” pieces of protein? Could reconnection for these loops give rise to pairs of flux tubes connecting the proteins in the transition to liquid phase (Option I)? Floppiness would also make possible to scan the environment by flux loops to get in touch with the flux loops of other molecules and in the case of hit (cyclotron resonance) induce reconnection.

2. In spite of floppiness in this sense, one could have quantum correlations between the internal quantum numbers of the building bricks of the floppy pieces. This would also increase the value of  $n$  serving as molecular IQ and provide molecule with higher metabolic energy liberated in the catalysis.

#### 4.4.2 About Comorosan effect and clustering of RNA II polymerase proteins

What about the interpretation of the time scales  $\tau$  equal 5, 10, and 20 seconds appearing in the clustering of RNA II polymerase proteins and Mediator proteins? What is intriguing that so called Comorosan effect [I7, I2] involves time scale of 5 seconds and its multiples claimed by Comorosan long time ago to be universal time scales in biology. The origin of these time scales has remained more or less a mystery although I have considered several TGD inspired explanations for this time scale is based on the notion of gravitational Planck constant [K35] (see <http://tinyurl.com/yb8fw3kq>).

One can consider several starting point ideas, which need not be mutually exclusive.

1. The time scales  $\tau$  associated with RNA II polymerase and perhaps more general bio-catalytic systems as Comorosan's claims suggest could correspond to the durations of processes ending with "big" state function reduction. In zero energy ontology (ZEO) there are two kinds of state function reductions [L3]. "Small" state function reductions - analogs of weak measurements - leave the passive boundary of causal diamond (CD) unaffected and thus give rise to self as generalized Zeno effect. The states at the active boundary change by a sequence of unitary time evolutions followed by measurements inducing also time localization of the active boundary of CD but not affecting passive boundary. The size of CD increases and gives rise to flow of time defined as the temporal distance between the tips of CD. Large reductions change the roles of the passive and active boundaries and mean death of self. The process with duration of  $\tau$  could correspond to a life-time of self assignable to CD.

**Remark:** It is not quite clear whether CD can disappear and generated from vacuum. In principle this is possible and the generation of mental images as sub-selves and sub-CDs could correspond to this kind of process.

2. In [K35] I proposed that Josephson junctions are formed between reacting molecules in bio-catalysis. These could correspond to the shortened flux tubes. The difference  $E_J = ZeV$  of Coulomb energy of Cooper pair over flux tube defining Josephson junction between molecules would correspond to Josephson frequency  $f_J = 2eV/h_{eff}$ . If this frequency corresponds to  $\tau_J = 5$  seconds,  $h_{eff}$  should be rather large since  $E_J$  is expected to be above thermal energy at physiological temperature.

Could Josephson radiation serve as a kind of synchronizing clock for the state function reductions so that its role would be analogous to that of EEG in case of brain? A more plausible option is that Josephson radiation is a reaction to the presence of cyclotron radiation generated at MB and performing control actions at the biological body (BB) defined in very general sense. In the case of brain dark cyclotron radiation would generate EEG rhythms responsible for control via genome and dark generalized Josephson radiation modulated by nerve pulse patterns would mediate sensory input to the MB at EEG frequencies.

A good guess motivated by the proposed universality of the Comorosan periods is that the energy in question does not depend on the catalytic system and corresponds to Josephson energy for protein through cell membrane acting as Josephson junction and giving to ionic channel or pump. The flux tubes themselves have universal properties.

3. The hypothesis  $\hbar_{eff} = \hbar_{gr} = GMm/\beta_0 c$  of Nottale [E2] for the value of gravitational Planck constant [K27, K20, K23, ?] gives large  $\hbar$ . Here  $v_0 = \beta_0 c$  has dimensions of velocity. For dark cyclotron photons this gives large energy  $E_c \propto \hbar_{gr}$  and for dark Josephson photons small frequency  $f_J \propto 1/\hbar_{gr}$ . Josephson time scale  $\tau_f$  would be proportional to the mass  $m$  of the charged particle and therefore to mass number  $A$  of ion involved:  $f_J \propto A$  possibly explaining the appearance of multiples of 5 second time scale. Cyclotron time scale does not depend on the mass of the charged particle at all and now sub-harmonics of  $\tau_c$  are natural.

The time scales assignable to CD or the lifetime-time of self in question could correspond to either cyclotron or Josephson time scale  $\tau$ .

1. If one requires that the multiplies of the time scale 5 seconds are possible, Josephson radiation is favoured since the Josephson time scale proportional to  $\hbar_{gr} \propto m \propto A$ ,  $A$  mass number of ion.

The problem is that the values  $A = 2, 3, 4, 5$  are not plausible for ordinary nuclei in living matter. Dark nuclei at magnetic flux tubes consisting of dark proton sequences could however have arbitrary number of dark protons and if dark nuclei appear at flux tubes defining Josephson junctions, one would have the desired hierarchy.

2. Although cyclotron frequencies do not have sub-harmonics naturally, MB could adapt to the situation by changing the thickness of its flux tubes and by flux conservation the magnetic field strength to which  $f_c$  is proportional to. This would allow MB to produce cyclotron radiation with the same frequency as Josephson radiation and MB and BB would be in resonant coupling.

Consider now the model quantitatively.

1. For  $\hbar_{eff} = \hbar_{gr}$  one has

$$r = \frac{\hbar_{gr}}{\hbar} = \frac{GM_D m}{c\beta_0} = 4.5 \times 10^{14} \times \frac{m}{m_p} \frac{y}{\beta_0} .$$

Here  $y = M_D/M_E$  gives the ratio of dark mass  $M_D$  to the Earth mass  $M_E$ . One can consider 2 favoured values for  $m$  corresponding to proton mass  $m_p$  and electron mass  $m_e$ .

2.  $E = \hbar_{eff} f$  gives the concrete relationship  $f = (E/eV) \times 2.4 \times 10^{14} \times (h/\hbar_{eff})$  Hz between frequencies and energies. This gives

$$x = \frac{E}{eV} = 0.4 \times r \times \frac{f}{10^{14} Hz} .$$

3. If the cyclotron frequency  $f_c = 300$  Hz of proton for  $B_{end} = .2$  Gauss corresponds to bio-photon energy of  $x$  eV, one obtains the condition

$$r = \frac{GM_D m_p}{\hbar\beta_0} \simeq .83 \times 10^{12} x .$$

Note that the cyclotron energy does not depend on the mass of the charged particle. One obtains for the relation between Josephson energy and Josephson frequency the condition

$$x = \frac{E_J}{eV} = 0.4 \times .83 \times 10^{-2} \times \frac{m}{m_p} \times x \frac{f_J}{Hz} , \quad E_J = ZeV .$$

One should not confuse  $eV$  in  $ZeV$  with unit of energy. Note also that the value of Josephson energy does not depend on  $\hbar_{eff}$  so that there is no actual mass dependence involved.

For proton one would give a hierarchy of time scales as  $A$ -multiples of  $\tau(p)$  and is therefore more natural so that it is natural to consider this case first.

1. For  $f_J = .2$  Hz corresponding to the Comorosan time scale of  $\tau = 5$  seconds this would give  $ZeV = .66x$  meV. This is above thermal energy  $E_{th} = T = 27.5$  meV at  $T = 25$  Celsius for  $x > 42$ . For ordinary photon ( $\hbar_{eff} = \hbar$ ) proton cyclotron frequency  $f_c(p)$  would correspond for  $x > 42$  to EUV energy  $E > 42$  eV and to wavelength of  $\lambda < 31$  nm.

The energy scale of Josephson junctions formed by proteins through cell membrane of thickness  $L(151) = 10$  nm is slightly above thermal energy, which suggests  $x \simeq 120$  allowing to identify  $L(151) = 10$  nm as the length scale of the flux tube portion connecting the reactants. This would give  $E \simeq 120$  eV - the upper bound of EUV range. For  $x = 120$  one would have

$GM_E m_p y / v_0 \simeq 10^{14}$  requiring  $\beta_0 / y \simeq 2.2$ . The earlier estimates [?] for the mass  $M_D$  give  $y \sim 2 \times 10^{-4}$  giving  $\beta_0 \sim 4.4 \times 10^{-4}$ . This is rather near to  $\beta_0 = 2^{-11} \sim m_e / m_p$  obtained also in the model for the orbits of the 4 inner planets as Bohr orbits.

For ion with mass number  $A$  this would predict  $\tau_A = A \times \tau_p = A \times 5$  seconds so that also multiples of the 5 second time scale would appear. These multiples were indeed found by Comoran and appear also in the case of RNA II polymerase.

2. For proton one would thus have 2 biological extremes - EUV energy scale associated with cyclotron radiation and thermal energy scale assignable to Josephson radiation. Both would be assignable to dark photons with  $h_{eff} = h_{gr}$  with very long wavelength. Dark and ordinary photons of both kind would be able to transform to each other meaning a coupling between very long lengths scales assignable to MB and short wavelengths/time scales assignable to BB.

The energy scale of dark Josephson photons would be that assignable with Josephson junctions of length 10 nm with long wavelengths and energies slightly above  $E_{th}$  at physiological temperature. The EUV energy scale would be 120 eV for dark cyclotron photons of highest energy would be fixed by flux tube length of 10 nm.

For lower cyclotron energies forced by the presence of bio-photons in the range containing visible [K2, K8] and UV and obtained for  $B_{end}$  below .2 Gauss, the Josephson photons would have energies below  $E_{th}$ . That the possible values of  $B_{end}$  are below the nominal value  $B_{end} = .2$  Gauss deduced from the experiments of Blackman [J1] does not conform with the earlier ad hoc assumption that  $B_{end}$  represents lower bound. This does not change the earlier conclusions.

Could the 120 eV energy scale have some physical meaning in TGD framework? The corresponding wavelength for ordinary photons corresponds to the scale  $L(151) = 10$  nm which correspond to the thickness of DNA double strand. Dark DNA having dark proton triplets as codons could correspond to either  $k = 149$  or  $k = 151$ . The energetics of Pollock effect suggests that  $k = 149$  is realized in water even during prebiotic period [L4] (see <http://tinyurl.com/yalny39x>). In the effect discovered by Blackman the ELF photons would transform dark cyclotron photons having  $h_{eff} = h_{gr}$  and energy about .12 keV. They would induce cyclotron transitions at flux tubes of  $B_{end}$  with thickness of order cell size scale. These states would decay back to previous states and the dark photons transformed to ordinary photons absorbed by ordinary DNA with coil structure with thickness of 10 nm. Kind of standing waves would be formed. These waves could transform to acoustic waves and induce the observed effects. Quite generally, dark cyclotron photons would control the dynamics of ordinary DNA by this mechanism.

It is natural to assume that  $B_{end} = .2$  Gauss corresponds to the upper bound for  $B_{end}$  since magnetic fields are expected to weaken farther from the Earth's surface: weakening could correspond to thickening of flux tubes reducing the field intensity by flux conservation. The model for hearing [K24] requires cyclotron frequencies considerably above proton's cyclotron frequency in  $B_{end} = .2$  Gauss. This requires that audible frequencies are mapped to electron's cyclotron frequency having upper bound  $f_c(e) = (m_p / m_e) f_c(p) \simeq 6 \times 10^5$  Hz. This frequency is indeed above the range of audible frequencies even for bats.

For electron one has  $h_{gr}(e) = (m_e / m_p) \times h_{gr}(p) \simeq 5.3 \times 10^{-4} h_{gr}(p)$ ,  $\hbar_{gr}(p) / \hbar = 4.5 \times 10^{14} / \beta_0$ . Since Josephson energy remains invariant, the Josephson time scales up from  $\tau(p) = 5$  seconds to  $\tau(e) = (m_e / m_p) \tau(p) \simeq 2.5$  milliseconds, which is the time scale assignable to nerve pulses [K25, K10].

To sum up, the model suggests that the idealization of flux tubes as kind of universal Josephson junctions. The model is consistent with bio-photon hypothesis. The constraints on  $h_{gr} = GM_D m / v_0$  are consistent with the earlier views and allows to assign Comorosan time scale 5 seconds to proton and nerve pulse time scale to electron as Josephson time scales. This inspires the question whether the dynamics of bio-catalysis and nerve pulse generation be seen as scaled variants of each other at quantum level? This would not be surprising if MB controls the dynamics. The earlier assumption that  $B_{end} = 0.2$  Gauss is minimal value for  $B_{end}$  must be replaced with the assumption that it is maximal value of  $B_{end}$ .

## 5 Subcellular Control And Wormhole Flux Tubes

### 5.1 Intracellular Bio-Control And Memory

Wormhole magnetic fields could provide a tool of quantum bio-control below cell length scales. For instance, cell nucleus could control from distance the motion of cell organelles using magnetic and  $Z^0$  magnetic fields generated by wormholes. In [K7] it is suggested that the winding numbers associated with closed wormhole flux tubes, which actually correspond to quantized momenta for wormhole supra currents, might provide a memory, which is very stable against perturbations. It must be however emphasized that the TGD based model of long term memory does not require any memory storage since memories are essentially re-experienced episodes of geometric past. Wormhole supra currents, and the entire zoo of various supra-currents predicted by quantum TGD, might however form cognitive representations and an important brain function would be the construction of this kind of representations as caricatures of the conscious experience.

### 5.2 Coding Of Genetic Information To Topologically Quantized Fields?

The mechanisms behind ontogeny leading from single cell to an adult individual are poorly known. The wormhole flux tubes represent spatial extension of bio-system to a larger quantum system via magnetic fields so that long distance control via topologically quantized magnetic field becomes possible. As suggested in [K5, K6], either the flux tubes of ordinary or wormhole magnetic field could serve as templates of bio-structures: more specifically, wormhole flux tubes could provide topological representation for defects of various bio-super conductors.

Various bio-structures are expected to be surrounded by a characteristic flux tube network extending over a spatial region considerably larger than structure itself and bio-structure could control the fluxes inside the individual flux tubes. The field configuration would somehow control the ontogeny. By the previous considerations also the coherent photons created by microtubules and possibly other linear structures, could control the state of magnetic flux tubes. Note that also ordinary super conductivity with topologically quantized wormhole flux tubes representing defects might be involved. In this case the wormhole magnetic field cancels the penetrating field in the larger space-time sheet and recreates it in the smaller space-time sheet.

One can wonder how the genetic information is coded into extended spatial structures and to what extent wormholes flux tubes and various related structures represent something genuinely new. The p-adic hierarchy of space-time sheets certainly breaks naïve reductionistic philosophy so that the dynamics of wormhole flux tubes and related structures is probably not completely determined by the genetic code. The idea about the flux tubes of magnetic field as templates for bio-structures does not support (or at least, does not require it) the idea about the coding of the magnetic structure to DNA and flux tube structure could be a result of self-organization process and topological field quantization. For instance, in case of DNA the structure of the topologically quantized wormhole magnetic field surrounding DNA (with quantized magnetic flux) can depend only on the general properties of the DNA sequence since only few topological quantum numbers are involved and it indeed seems that these quantum numbers are determined by the dynamics at larger length scales in accordance with Slaving Principle. On the other hand, the structure of the wormhole magnetic fields in length scales shorter than DNA could be determined completely by the structure of DNA sequence.

### 5.3 Are Magnetic And Wormhole Magnetic Fields Involved With The Control Of Gene Expression?

The development of organism is a complicated self-organization process during which gene expression is controlled by the feedback from long length scales. The mechanism of this “biofeedback” is poorly understood. It is not even known whether it is really chemical. In fact, it is known that besides the chemical transcription factors (proteins) controlling gene expression, there are non-chemical transcription factors called silencers and enhancers, whose action mechanism is not known [K16], [I1]. Magnetic and wormhole magnetic fields could indeed be involved with the control of gene expression performed by growing organism using Josephson currents.

1. As suggested in [K22, K21], magnetic and perhaps also wormhole magnetic fields could be involved with the gene expression via Josephson currents and make possible biological alarm clocks “waking-up” gene self and initiating gene expression. Complicated circuits, involving pattern recognizers, comparison circuits and novelty detectors could serve as building bricks of logical circuits conditioning the gene expression to begin only when certain conditions are satisfied.
2. The realization of the alarm clock would be following. Ions and electrons form in the magnetic fields or wormhole magnetic fields bound states characterized by cyclotron frequencies. When the potential difference between the space-time sheets representing two weakly couple super conductors connected by the join boundaries bonds representing Josephson junctions equals to a magnetic transition frequency of a charge carrier in either superconductor, quantum jumps occur and “wakes-up” the “clock self” and initiate thus self-organization process.
3. One can imagine that the genetic alarm clock is formed by Josephson junction formed by one of the many space-time sheets associated with the many-sheeted DNA and the space-time sheet of the growing organ [K16]. The size of the space-time sheet correlates with the vacuum frequency  $\omega_1$  of the space-time sheet (there are two frequency type vacuum quantum numbers denoted by  $\omega_1$  and  $\omega_2$  [K4] and a natural assumption is that the difference of the frequencies  $\omega_1$  associated with the gene space-time sheet and organ’s space-time sheet corresponds to the electromagnetic potential difference over Josephson junction:  $\Delta\omega_1 = ZeV$ . When this difference equals to the energy difference for the states localized in either super conductor, the superconductor “wake up”. Thus a precise timing for the wake-up results and the initiation of the gene expression correlates in a precise manner with the size of the organ. This is something highly nontrivial: chemical transcription factors are concentrations and it is very difficult to imagine how concentrations, which carry purely local information, could code precise information about the size of the organ and even use it to control purposes.
4. If the states are cyclotron states confined in (wormhole) magnetic fields, the energy difference is in general case difference for multiples of the corresponding cyclotron frequencies. This flow of charge would eventually lead to the “wake-up” of the gene and initiate the self-organization process leading to gene expression.

## 5.4 Wormhole Flux Tubes As Templates Of Bio-Structures

One aspect of control of ontogeny is that part of a flux tube structure could serve as a template in the sense that bio-matter gathers around flux tubes during ontogeny. According the considerations of [K5, K6], magnetic or wormhole magnetic fields could provide general representation for the defects of super conductors. Microtubules, axons and very many other basic bio-structures are indeed *hollow* cylinders identifiable as defects of super conductors of type II (electronic super conductors). It is also known that macroscopic cylindrical bio-structures such as legs are characterized by winding numbers (for rather peculiar consequences, see [A1] ): this suggests that wormhole condensates associated with the boundaries of bio-sub-structures of all sizes play important role in bio-control. The stripe like structures (cell membranes, epithelial sheets, larger bi-layered structures of brain) could in turn correspond to defects of super conductors of type I (neutrino super conductors).

Ordinary atom could topologically condense on the interior of the flux tubes and topological condensation could become stable if one or more valence electrons is dropped on the “lower” space-time sheet of the flux tube. The resulting atom would be “exotic atom” with chemical properties those of atom having  $Z$  smaller by one unit (electronic alchemy!). As a matter of fact, the potential importance of the wormhole concept became clear from the attempt to explain the peculiar properties of so called ORMEs [H3] in terms of the concept of exotic atom [K5, K6].

The formation of exotic atoms might have been the basic step from the ordinary chemical evolution to bio-evolution. The process would be amplified by the presence of wormholes on the magnetic flux tube just like the formation of BE condensate is catalyzed by the presence of already existing seed of BE condensate (condensation probability is proportional to  $N^2$ , where  $N$  is the number of bosons in ground state). The possibility that Na, K, Ca ions in cell could be really exotic atoms with  $s$  wave valence electron(s) dropped on the lower space-time sheet, is not excluded.

## 6 TGD Inspired Models For Psychokinesis

The reality of psychokinesis (PK) as of also other psi phenomena is subject of a continuous debate and it seems that opinions are not always based on rational arguments. I am personally neither believer nor non-believer of psi phenomena but regard it as important (and also entertaining) to try to find rational testable models for psi rather than ridiculing or mystifying it. Indeed, in the following a TGD inspired model of psychokinesis is considered.

The basic philosophy of the model is following. PK is not just some isolated exotic phenomenon but only a special case of the voluntary control of bodily motions, which we all routinely perform. The only difference is that the range of voluntary control extends over the boundaries of the body in case of PK. This leads to an important conclusion: PK phenomena must involve classical long range fields, which give for bio-systems spatial extension larger than what is visible (that is hands with which to grasp on external object!). According to TGD inspired theory of consciousness, cell and even DNA can be conscious and perform choices. Thus the model should also provide understanding about small scale bio-control such as the (voluntary!) control of the motion of cell organelles performed by cell nucleus. A related problem is how genetic code is transformed into spatial structures during ontogeny, and the idea that each DNA sequence corresponds to a characteristic classical field configuration, is attractive. Thus the model in question is not meant to be an ad hoc solution of a particular problem called PK but a general solution of several basic problems in biology.

### 6.1 Wormhole Magnetic Fields And Psychokinesis

The model for psychokinesis is fixed to rather high degree by the following arguments.

#### 6.1.1 PK as a special case of voluntary action

Our subjective experience tells that our bodily motions are controlled by our free will. Only the fact, that we are so familiar with this PK in the scale of our own body, makes us believe that nothing peculiar is involved. This suggests that PK-able persons differ from ordinary people in that they can perform PK also in length scales larger than their own body. PK is probably possible and probably occurs also below cell length scales, say in the control of motions of cellular organelles by nucleus. Also DNA and microtubules could perform PK. The only logical conclusion is that PK, as well as voluntary control of motion, involves long range classical fields effectively giving for PK-able system hands with which to grasp on the external object.

#### 6.1.2 Quantum entanglement and PK

Quantum entanglement plays basic role in TGD inspired theory of consciousness and this is especially so for TGD inspired model of psi phenomena such as telepathy [K26]. Therefore it is assumed that PK mechanism involves quantum entanglement of some part of brain B with some part S of body such that S has ability to generate some classical field, which affects the material object. The field depends sensitively on quantum state of S so that the control becomes possible via B-S entanglement and quantum jumps reducing the entanglement. The most promising classical fields are magnetic fields (ordinary or  $Z^0$ -).

p-Adic considerations might exclude the possibility of PK in many cases. Suppose that, as strongly suggested by QFT limit of TGD, the space-time sheets indeed have effective p-adic topology characterized by p-adic prime. The tensor product for p-adic state spaces with different p-adic primes  $p_1$  and  $p_2$  gives rise to  $R_p$  valued state space, where  $p$  is the p-adic prime associated with the entire system. There are some reasons to believe that  $p_1 \neq p_2$  quantum entanglement is rare phenomenon: if true this implies the decomposition of the space-time into separate space-time sheets labelled by primes and behaving more or less classically with respect to each other: this is certainly in accordance with the everyday intuition. An immediate consequence is that subsystems of brain can get quantum entangled mostly with subsystems having same  $p$ . Furthermore, the space-time sheet for the object of PK should be such that magnetic field created by PK is on the space-time sheet at which it the object has suffered topological condensation.



### 6.1.3 Bio-systems and classical $Z^0$ fields

Bio-matter must be in special position as far as PK is considered and thus cell length scale should be somehow in special role in the possible explanation of PK. Indeed, TGD predicts that the prime  $p \simeq 2^{169}$  corresponds to the primary condensation level of neutrinos (on basis of data from latest neutrino mass experiments [K17]). The corresponding p-adic length scale corresponds to cell size. This p-adic condensation level is also the p-adic condensation level at which nuclei must feed their  $Z^0$  charges, where they in turn are screened by neutrinos (this requirement is necessitated by the stability of condensed matter against *classical* long range  $Z^0$  force). In this manner one also avoids the large parity breaking effects caused by classical  $Z^0$  fields, if present in atomic length scales.

Thus *neutrinos* and *classical  $Z^0$  force* correspond to the new TGD-based physics emerging at cell length scale. TGD neutrinos are predicted to be super-conducting and classical  $Z^0$  magnetic fields break the super conductivity: an attractive possibility is that cell membranes and endoplasmic membranes correspond to the defects in the resulting superconductor of type I. The explanation of chirality selection [K11] in terms of  $Z^0$  magnetic fields and neutrinos and of tritium beta decay anomaly [K29] provide strong support for this picture. The additional important piece of new physics important for bio-systems is related to *wormhole contacts*. For instance, wormhole contacts are created when electrons of ordinary atom drops from atomic space-time sheet to a larger space-time sheet parallel to it. This process leads to so called exotic atom [K5, K6] explaining the peculiar properties of so called ORMEs [H3]. In fact, the dropping of electron on larger space-time sheet might have been a (perhaps even the!) crucial step in transforming chemical evolution to bio-evolution. Also the penetration of classical electric and magnetic fields from a space-time sheet to another one requires the presence of charged wormholes and classical em fields are known to be very important in bio-systems.

In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant  $h_{eff}$  so that cyclotron energy would be liberated.

### 6.1.4 Magnetic levitation as a basic mechanism of PK

The simplest possibility is PK effect is based on magnetic levitation. Both classical magnetic and  $Z^0$  magnetic fields can give rise to the effect. This requires that all objects which can be moved by PK, must be diamagnetic and repel from their interior external magnetic fields by generating currents on their boundaries. If they behave like superconductors (in some sense) this is indeed the case.

Wormholes feed the gauge flux from a smaller p-adic space time sheet to a larger one and the throats of the wormhole look like classical charges of opposite sign coupling to the difference of classical fields associated with the two space-time sheets. When looked from embedding space context, they can be regarded as extremely weak dipoles and their coupling to vapor phase photons is extremely weak, which explains why they have not been observed via radiation. Wormhole Bose-Einstein condensates are a purely TGD-based phenomenon.  $Z^0$  wormholes have classical  $Z^0$  interaction with atomic nuclei screened by neutrinos and this in turn couples them to phonons and electromagnetic interactions indirectly. If  $Z^0$  are in thermal equilibrium with ordinary matter then wormhole Bose-Einstein condensates are possible in the length scales below  $L = 1/T$  ( $T$  is temperature, in room temperature  $L$  is about  $10^{-5} - 10^{-4}$  meters).

Wormhole BE-condensate behaves in many respects like super conductor. Thus wormhole superconductivity is a possible candidate for a mechanism behind PK. What is required is that the density of wormholes on the boundary of the object is high enough so that surface currents can cancel external magnetic field and magnetic levitation becomes possible. Charged wormholes provide also a mechanism of electronic bio-super conductivity and also this might be involved in PK as it possibly appears in bio-control.

### 6.1.5 Topological field quantization could make possible precise quantum control of magnetic fields

Bio-system must have an ability to create and control in precise manner magnetic fields. The only manner to achieve this is to construct magnetic field from magnetic flux tubes with *quantized magnetic fluxes*. Actually, the decomposition into flux tubes with quantized magnetic fluxes occurs *automatically* for any magnetic field in TGD [K15]. This is due to the induced gauge field concept: the embedding of classical gauge field as induced gauge field in general fails outside some region and 3-surface with boundary is generated (in [K15] these regions were christened as topological field quanta). Since wormholes form a Bose-Einstein condensate on the boundaries of flux tubes, topological field quantization actually makes the classical magnetic field quantum object and potential conscious being if TGD inspired theory of consciousness is correct! Control of the magnetic field occurs via the control of the order parameter describing the state of the wormhole condensate.

PK mechanism could be at work below cell length scale for ordinary magnetic fields and it is tempting to speculate that this kind of PK is one of the basic mechanisms of intracellular control. For instance, cell nucleus could control from distance the motion of cell organelles using magnetic and  $Z^0$  magnetic fields generated by wormholes. Also microtubules and perhaps even DNA could apply PK mechanism for control purposes. In longer length scales, much above the cell length scale,  $Z^0$  type wormhole magnetic fields might be important.

### 6.1.6 Order of magnitude estimates

One can imagine several mechanisms for the penetration of the magnetic and wormhole magnetic fields. If the size of the object is small as compared to the thickness of the flux tube, the wormhole magnetic field at either sheet can penetrate (or try to penetrate in present case!) to the space-time sheet of an object topologically condensed at the space-time sheet of the flux tube. When the size of the object is larger than the thickness of the magnetic flux tube, situation is more complicated: a similar microscopic mechanism could however be at work also in this case since the object contains hierarchy of smaller space-time sheets topologically condensed on it. The following discussion neglects these complications and treats the (wormhole) magnetic field as ordinary classical fields: intuitively the idealization of the flux tube structure with ordinary classical magnetic field seems natural.

The energy for creating and changing magnetic or wormhole magnetic fields must come from the metabolism. Dissipation effects are expected to be small since wormholes behave as a superconductor. Super conductivity (perfect diamagnetism) is not necessary, also nonperfect diamagnets can levitate. In case of superconducting object the strength of the magnetic field must be smaller than the critical field destroying the super conductivity; this condition is a crucial limitation for PK based on super conductivity.

A rough order of magnitude estimate for the needed magnetic field strengths is obtained in the following manner. Meissner force is the gradient of the magnetic field energy regarded as a function of the position of the object located in the field. For simplicity, assume that (wormhole) magnetic field depends linearly on the coordinate  $z$  in the direction of gravitational field

$$B = B_0 \left(1 + \frac{z}{h}\right), \quad (6.1)$$

where  $h$  is the characteristic scale of variation for the wormhole magnetic field.

The Meissner force experienced by an object having size much smaller than scale  $h$ , so that the magnetic field is essentially constant in the volume of the object, is from a rough order of magnitude estimate

$$F \sim -\frac{dE_{magn}}{dz},$$

$$E_{magn}(z) \simeq \frac{1}{2} B^2 V = \frac{B_0^2 V}{2} \left(1 + \frac{z}{h}\right)^2, \quad (6.2)$$

where  $E_{magn}$  is the magnetic field energy contained in the volume  $V$  of the object. For the lifting of an object with mass  $m$  in the gravitational field, this force must have a magnitude larger than the

gravitational force  $F = mg$ , where  $g$  is gravitational acceleration. This gives an order of magnitude estimate for the minimum magnetic field  $B_0$  making the lifting of the object possible:

$$B_0 \sim \sqrt{\rho gh} , \quad (6.3)$$

where  $\rho$  is the density of the object. Note that in the approximation that magnetic field is essentially constant in the volume of the object, the estimate does not depend on the size or form of the object. More generally, the gradient of  $B$  is roughly the gravitational force divided by the average magnetic field  $B_0$ :  $\frac{dB}{dz} \sim \frac{\rho g}{B_0}$ .

An order of magnitude estimate is obtained by putting  $\rho \sim 10^3 \text{ kg/m}^3$  (density of water roughly) and  $h \sim 10^{-2} \text{ meters}$  (object could be a sheet considerably thinner than one centimeter). In this case magnetic field  $B_0$  of order  $10^{-5} \text{ Tesla}$  is needed.

Consider first ordinary super conductivity and ordinary magnetic fields (assuming object to be super conductor). Hudson claims that the critical magnetic fields for ORME superconductivity are of the order of Earth's magnetic field, about  $10^{-7} \text{ Tesla}$ . The claim concerns ordinary magnetic field, not wormhole magnetic fields, and thus electronic superconductivity should be in question. If the claim gives general order of magnitude then the needed magnetic field would destroy the electronic super conductivity. By reducing the thickness of the object to the cell length scale of order  $10^{-6} \text{ meters}$ , one finds that the needed magnetic field is of order  $10^{-7} \text{ Tesla}$  so that the effect might be possible below cell length scales and cell nucleus might control the motion of cell organelles by PK based on the ordinary magnetic fields and electronic super conductivity.

Second case corresponds to wormhole super conductivity (object must be wormhole super conductor). Since wormhole magnetic fields are new physics, one can make only order of magnitude guesses. "Ordinary" wormhole magnetic fields can exist in arbitrarily short p-adic length scales and there is no obvious upper bound for the critical wormhole magnetic field in this case. Since  $Z^0$  classical fields appear only in the p-adic length scales not smaller than the cell length scale, p-adic length scale hypothesis suggests that the critical wormhole magnetic field is in this case *at most* of the order  $1/L(\text{cell})^2$  in units ( $\hbar = c = 1$ ). This gives  $B_0 \leq 10^{-4} \text{ Tesla}$ . This would be enough in the previous example with a sheet like object having the density of water and thickness below one centimeter. Note that thin sheets are ideal objects for the experimental verification of the effect.

## 6.2 Alternative Models Of Psychokinesis

The manner TGD solves the energy problem of GRT is simple: energy momentum tensor is replaced by a collection of vector fields so that the energy defined as an integral over 3-space is coordinate independent scalar quantity. Vector field nature however implies that the sign of the energy depends on the time orientation of the space-time sheet and one can quite well consider the possibility that the time orientation of the space-time sheet is not always same as the natural time orientation of the future light-cone. This would make possible negative energies and "buy now, pay later" type mechanism of energy production by the generation of negative energy space-time sheets of possibly finite time duration. One can even consider the possibility that entire universe is generated from vacuum and has vanishing total quantum numbers.

In [K33] this mechanism is discussed as an explanation for certain peculiar looking claims about energy production occurring with efficiency larger than one. (the N-machine of DePalma [H2] and the space energy generator of [H1]). The model also explains why the rotation of a system consisting of a conductor disk rigidly attached to a cylindrical magnet generates potential difference between the axis and rim of the conducting disk. This effect, observed already by Faraday, has no satisfactory explanation in ordinary electrodynamics. In TGD framework the explanation is simple: the mere rotation of the 3-surface generates the radial electric field automatically. The divergence of the electric field associated with the Faraday disk is non-vanishing and gives rise to vacuum charge density and this in turn implies the necessity of second space-time sheet with opposite charge density and possibly opposite time orientation.

One can consider the possibility that "mind-like" space-time sheets could have negative time orientation so that pairs of space-time sheets with opposite time orientations could be the basic characteristic of living matter. In fact, only this option could make possible the realization of Boolean mind relying on electron positron pairs. Note that also wormhole magnetic fields could

correspond to pairs of space-time sheets having opposite time orientation. If this picture is correct, psychokinetic effects could occur spontaneously in living systems when mind-like space-time sheets with negative time orientation are generated and material space-time sheet receives compensating positive energy. This mechanism would make possible “poltergeist” effects involving generation of kinetic energy from “nowhere” and would make possible to affect the physical world by mere thought! There also legends about the magic feats of the trained yogis. Sceptics have of course strong opinions concerning these stories: I would be happy if I could share with the sceptics their access to deeper knowledge making life so simple. I do not even know whether we might be affecting everydayly that part of the physical world which we identify as our physical body by this mechanism!

TGD suggest also a third mechanism of PK. Space-time sheets form a hierarchy. Our space-time sheet is usually glued to the space-time sheet of Earth so that we feel the gravitational force of Earth. One could however consider the possibility that “our” space-time sheet could in some manner get glued to a larger space-time sheet at which Earth’s gravitational field is not felt appreciably. This would make possible levitation. This kind of effect would also make the apparent fusion of solid bodies and an effect that might be called “Houdini effect”. The occurrence of this effect in atomic length scales makes possible to bypass Coulomb walls and has been suggested as a mechanism of cold fusion in [K29].

### 6.3 Experimental Tests

The basic concept is topological field quantization implying the decomposition of magnetic field to flux tubes. This indeed occurs in super conductors. Actually, it might be that this phenomenon can be demonstrated using just child’s toy magnet! The ferrite powder on table indeed concentrates on lines in the vicinity of magnet. I do not know whether this phenomenon has a more mundane explanation or is it really a direct manifestation of topological field quantization.

The simplest experimental proof for the wormhole flux tube idea is to make them visible! One could achieve the situation in which atoms are condensed on wormhole flux tubes and form exotic atoms so that also electronic alchemy occurs: one can hardly imagine more dramatic proof of the concept! A second possibility is the interaction of laser light with wormhole flux tubes if the proposed explanation of phantom DNA effect is correct. The recent progress in understanding of high  $T_c$  superconductivity [K5, K6] gives indeed very strong indirect support for the notion of wormhole contact as parton-antiparton pair as well as for the notion of dark matter as large  $\hbar$  phase of ordinary matter.

There are two possible realizations for PK in the proposed model. Either in terms of ordinary topologically quantized magnetic field and super conductivity or in terms of wormhole super conductivity and corresponding magnetic fields, which always appear on *two* space-time sheets simultaneously and thus forming twin structures. The essential requirement is that magnetic field is on the space-time sheet at which the object has suffered topological condensation. Also the restrictions from p-adic quantum entanglement and from many-sheetedness of the space-time could be decisive and explain why the phenomenon is so rare.

The basic concept is topological field quantization implying the decomposition of the magnetic field to flux tubes. This indeed occurs in super conductors. It might be that this phenomenon can be demonstrated by child’s toy magnet! The ferrite powder on table indeed concentrates on lines in the vicinity of magnet. I do not really know whether this phenomenon has a more mundane explanation or is it really a direct manifestation of topological field quantization.

If PK-able persons can control also ordinary magnetic fields created by ordinary charges then one can consider an experiment in which PK-able person tries to affect the state of an ordinary super conductor.

The simplest experimental proof for the wormhole flux tube idea is to make them visible. One could achieve the situation in which atoms are condensed on wormhole flux tubes and form exotic atoms so that also electronic alchemy occurs: one can hardly imagine more dramatic proof of the concept! A second possibility is the interaction of laser light with wormhole flux tubes if the proposed explanation of phantom DNA effect is correct.

Also an experiment in which PK-able person tries to affect the motion of ORMEs [H3] (material possible containing exotic atoms predicted by TGD), could be considered. Actually, peculiar levitation effects have been claimed and also the proposed interpretations have been based on

some kind of magnetic levitation and super conductivity. The original explanation was in terms of electronic super conductivity but on the light of recent results wormhole super conductivity seems to be a more plausible explanation. PK effect could be involved also with the claimed fluctuations in the weight of the ORMEs [H3] . PK effect might lead to an fluctuations in the high precision measurements of the value of gravitational constant. An interesting possibility is whether also ORMEs exhibit phantom ORME effect analogous to phantom DNA effect [I8] having explanation in terms of wormhole super conductivity.

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