Magnetic Bubbles in TGD Universe: part II

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Abstract

Solar flares involving mass eruptions accompany sunspots and the reversal of the magnetic polarity of the solar magnetic field. The models however have several problems. For instance, it is believed that reconnections of magnetic field lines are essential for the process but the prediction for the rate of the process is by 13-14 orders of magnitude too low. The TGD view of space-time provides a new view of electromagnetic fields based on the notion of a field body. Dark matter as phases of ordinary matter with a large value of effective Planck constant is the second new idea and zero energy ontology (ZEO) provides a third new ingredient.

The recent advances in the understanding of the formation of astrophysical structures in various scales in the TGD framework inspire the attempt to understand the structure of the solar magnetic field and its dynamics involving solar cycle, solar flares, reconnections and reversal of the solar magnetic field. By fractality, the general vision leads to a concrete model for the solar cycle and strongly suggests a concrete analogy of the solar cycle with the basic rhythms appearing in biological systems and the identification of the counterparts of anabolism and catabolism at the fundamental level.

The general picture also leads to a model for the reversals of the Earth's magnetic field and to interesting speculations concerning their connection with the evolutionary leaps. In zero energy ontology, the reversal involves the decay and re-organization of the magnetic body in zero energy ontology. The decay is analogous to the decay of the biological body after death and induces it. This interpretation provides an understanding of the so-called Tukdam phenomenon.

Contents

1 Introduction

The finding that motivated these comments was the finding of what was so-called solar heartbeat [E3] (https://rb.gy/7gaa78). Two kinds of quasiperiodic pulsations (QPPs) with periodicities 10-20 s and 30-60 s of microwave emissions during solar flares. These periods are correlated and probably have the same underlying reason. A kind of solar heartbeat is in question. It might be assignable with the reconnection process for the solar magnetic field. The notion of magnetic reconnection is however poorly understood in the standard physics framework: the estimates for the reconnection rate are by 13-15 orders of magnitude too small.

The TGD framework leads to a new view of space-time as a 4-D surface in $H = M^4 \times CP_2$ and also of electromagnetic and other fields. In particular, fields are replaced by topological field quanta identifiable as space-time quanta. One ends up with the notion of a field body, in particular that of a magnetic body (MB) consisting of monopole flux tubes not possible in Maxwell's electrodynamics and flux tubes with boundaries serving as counterparts of Maxwellian magnetic fields.

Could periodic reconnections of closed flux tubes with the shape of a very flat square caused by the transverse oscillations of the flux tubes occurring during solar flares induce the periodic reconnections of flux tubes? Microwave frequencies for dark charged matter at the flux tubes could be due to cyclotron transitions.

What could be the origin of the periodicities of transversal oscillations? I have earlier discussed [L4] the 26 second rhythm of Earth [L4] analogous to alpha rhythm. Intriguingly, this period is between the mentioned periods. Could the Earth's alpha rhythm and solar heartbeat relate to each other? This might be considered in the TGD framework if the rhythms are associated with gravitational monopole flux tubes emerging from the Sun and connecting the gravitational magnetic bodies of Earth and Sun to a single quantum coherent entity.

This finding inspired the attempt to understand solar flares in the TGD framework.

1.1 Basic problems of the existing models of solar flares

The models for the solar flares (https://rb.gy/yw5jpd) have several problems.

1. The source of the flare's energy is believed to be magnetic but what is the basic mechanism? How the magnetic energy is transformed to the kinetic energy of particles? How accelerations to energies in GeV range and beyond are possible? In the standard framework extreme accelerations would be required.

2. Reconnection of magnetic field lines is believed to be the basic mechanism but the predicted rate of reconnections is by 13-14 orders of magnitude too small. There might be something fundamentally wrong with the notion of reconnection.

3. There are also inconsistencies regarding the total number of accelerated particles. Sometimes this number is larger than the total number in the coronal loop. Where could the additional particles come from?

4. It is not possible to forecast flares.

1.2 The notion of reconnection is questionable

The Maxwellian notion of reconnection can be challenged. Field lines rather than flux tubes which reconnect. Note however that the notion of flux tubes is used in the phenomenology of MHD.

The rate of reconnections based on the Maxwellian picture assumes that the reconnection rate is proportional to the electric field associated with the separatrix at which the reconnection of field lines occurs. The actual reconnection rate for solar flares is by 13-14 orders higher than predicted so that something is badly wrong. The fact that conductivity can vary in huge limits suggests that charges for which conductivity is very high or even superconducting matter might be present.

Could the TGD view of reconnection help? Monopole flux tubes or flux tubes with boundaries as counterparts of Maxwellian magnetic fields carrying currents as dark matter in the TGD sense might provide a more realistic approach and the rate of connection could be estimated from classical dynamics for preferred extremals.

1.3 Is the Maxwellian view of currents and plasma correct?

When the conductivity of charge carriers is effectively infinite, Maxwellian MHD currents are frozen to flux lines. In the TGD framework, the Maxwellian flux tubes having boundaries could carry ordinary ohmic currents. Could dark particles at monopole flux tubes flow like supra current with vanishing resistance? At least these currents could correspond to currents frozen to field lines.

The absence of dissipation for the dark matter at the monopole flux tubes could explain the presence of ultra-energetic particles and the strange finding that solar flare can involve more particles than contained by the flare. The reconnection process gives rise to a pair of U-shaped flux tubes, which are highly curved. Could the dark particles leak out from the flux tubes in the reconnection process and transform to ordinary particles. There would be no gigantic acceleration since the dark particles would already have very high energies.

What about the TGD counterpart of plasma? Does the plasma correspond to the ordinary electrons at flux tubes with boundary or to the dark electrons at the gravitational monopole flux tubes? A possible TGD view of quark gluon plasma [L19] is that sea partons reside at the MB of hadrons and are dark in the TGD sense. Could the dark current carriers be analogous to sea partons? Could ordinary charge carriers with ohmic resistance serve as the analogs of valence quarks?

The answers to these questions requires a TGD based formulation of the basic concepts of plasma physics and magnetohydrodynamics (MHD) of the Sun.

1. MHD (`https://rb.gy/kv09cj`) and plasma physics (`https://rb.gy/g6wxyl`) must be reconsidered in [L10] in terms of the TGD based view of electromagnetic fields.

2. The new geometric view of magnetic fields forces a reconsideration of the notions of solar magnetic field and related notion of Parker spiral, coronal loops `https://rb.gy/gedbk2`), current sheets (`https://rb.gy/8yw1r8`) and `https://rb.gy/n0cyoe`).

3. The dynamics of the solar magnetic field involves several notions, which must be reformulated in the TGD framework. Sunspot cycle (`https://rb.gy/cvu4av`) and `https://rb.gy/rigawy`) must be understood in the TGD framework. Solar activity is maximum is assignable to the polar reversal of the solar magnetic field. There are many poorly understood phenomena related to the polar reversal such as solar flares (`https://rb.gy/yw5jpd`) and magnetic reconnections (`https://rb.gy/sbktub`) about which TGD could provide insights. Magnetic reconnection is an especially poorly understood notion: in the standard model the rate for their formation is 13-14 orders of magnitude too low.

The recent advances in the TGD based understanding of the formation of astrophysical structures in various scales [L21] lead to a general vision, which inspires the attempt to understand the structure of the solar magnetic field and its dynamics involving solar cycle, solar flares, reconnections and reversal of the solar magnetic field. By fractality, the general vision leads to a concrete model for the solar cycle and strongly suggests a concrete analogy of the solar cycle with the basic rhythms appearing in biological systems and the identification of the counterparts of anabolism and catabolism at the fundamental level.

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2 A TGD inspired model for solar flares

In the sequel a TGD based view of the reversal of the solar magnetic field is discussed. Besides the new view of space-time and electromagnetic fields, the proposal involves in a crucial manner zero energy ontology (ZEO) [L5, L23, L18].

2.1 The motivating finding

The finding that motivated these comments was the finding of what was called solar heartbeat [E3] (`https://rb.gy/7gaa78`). Two kinds of quasiperiodic pulsations (QPPs) with periodicities 10-20 s and 30-60 s of microwave emissions during solar flares. These periods are correlated and probably have the same underlying reason. A kind of solar heartbeat is in question. It might be assignable with the reconnection process for the solar magnetic field. The notion of magnetic reconnection is however poorly understood in the standard physics framework: the estimates for the reconnection rate are by 13-15 orders of magnitude too small.

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2.3 A TGD based view of the polarity reversal of the solar magnetic field

In the sequel a TGD based view of the reversal of the solar magnetic field is discussed. Besides the new view of space-time and electromagnetic fields, the proposal involves in a crucial manner zero energy ontology (ZEO) [L5, L23, L18].

2.3.1 TGD counterpart of the Maxwellian magnetic field

Flux tubes carrying magnetic fields replace the flux lines of the Maxwellian theory. TGD predicts two kinds of flux tubes: monopole flux tubes with closed cross section and Maxwellian flux tubes with boundary. There is an analogy with the fields H and M of Maxwell's theory.

The Maxwellian part of the magnetic field could correspond to magnetization M having as the TGD counterpart flux tubes with boundary carrying currents generating the fields in the interior of the flux tube. The field H of Maxwell's theory could correspond to monopole flux tubes and could induce magnetization M as Maxwellian part of the magnetic field. Monopole flux tubes and Maxwellian flux tubes could correspond to parallel space-time sheets.

The monopole flux part of the magnetic field differs in several respects from the Maxwellian part.

1. The magnetic fields at monopole flux tubes require no current to maintain the magnetic field. The presence of monopole flux tubes allows us to understand the existence of magnetic fields in cosmic scales and also the maintenance of the magnetic field of Earth [L2].

2. Monopole flux tubes would carry charged dark matter characterized by effective Planck constant $h_{eff} = nh_0$. Especially interesting flux tubes are gravitational flux tubes with gravitational Planck constant $\hbar_{eff} = \hbar_{gr} = GMm/\beta_0$, where $\beta_0 = v_0/c < 1$ is velocity parameter, and M is large mass of say Sun or Earth and m corresponds to small mass such as electron mass. This notion was introduced first by Nottale [E2].

   The freezing of the charge carriers to the flux lines would have a concrete interpretation. The freezing could occur also for the Maxwellian flux tubes and charge carriers would be at the boundaries of the flux tubes. The large value of h_{eff} implies large scale quantum coherence and the monopole flux part of the MB would naturally serve as a "boss" controlling the dynamics at the lower levels of hierarchy. This motivates the interpretation as counterpart for the field H.

3. Maxwellian parts of the magnetic fields could be generated by currents at the boundaries of the flux tubes if conductivity is very large. The flux tubes would be analogous to current wires. Magnetization M could correspond to the flux tubes with boundary, which carry the currents inducing the magnetic field in the interior. Magnetization would occur for the charged particles at the boundaries of these flux tubes.

4. The thickening of dark flux tubes is a phase transition liberating magnetic and volume energy and also dark matter if part of it transforms to ordinary matter in the process. Extreme accelerations would not be required since the dark particles forming quantum coherent phases at the flux tubes would have very high energies due to the very low dissipation. This could explain the huge production of energy and anomalously high particle energies.

5. For the topological counterpart of the reconnection process, field lines are replaced by flux tubes. When a closed flux tube has the shape of a very narrow rectangle, it is critical against reconnection, which could involve the chance of h_{eff}. The dark charge carriers leaked out of the flux tubes would have the ordinary value $h_{eff} = h$ of the effective Planck constant.

2.3.2 A model for the reconnection

There was an interesting article in Quanta Magazine about the reconnections of the magnetic fields for astrophysical objects (`rb.gy/npoc0`). Two kinds of reconnections have been observed. The slow ones for which the Maxwellian electrodynamics provides a satisfactory description and the fast ones, which are not understood.

Fast reconnections liberate magnetic energy powering solar flares and solar wind, high-energy particles ejected by exploding stars, and the glow of jets from black holes. The popular article told about a theory of Yi-Shin Liu et al (`rebrand.ly/6uv3jb3`) claimed to allow the understanding of the fast reconnections in the Maxwellian framework. The model assumes that reconnection is induced by a generation of electric fields for instance by different velocities of protons and electrons moving along the flux lines.

Personally I am a little bit skeptical. There are many other enigmas related to magnetic fields in cosmic scales. Particular, the existence and stability of magnetic fields in astrophysical scales is a mystery in the Maxwellian framework. Also these problems should be solved.

In the TGD Universe, the flux lines are replaced with flux tubes which can be seen as bundles of flux lines assignable to 3-D surfaces in $M^4_2 having 4-D space-time surfaces as orbits. Reconnection of flux lines is rep$
$space as 3-surfaces othat topological reactions for 3-surfaces are in question : this conforms with "Topological Geo$

Intriguingly, TGD allows two kinds of flux tubes.

1. Flux tubes with a disk as cross section and having a boundary correspond to the Maxwellian situation. Cross section can be also closed but if the flux vanishes, the flux tube is not stable against splitting.

   The Maxwellian flux tubes with open cross section require currents to create the magnetic field. Currents tend however to dissipate so that the Maxwellian flux tubes and corresponding magnetic fields are not stable. This leads to a problem in understanding why magnetic fields in astrophysical scales are so stable.

2. The monopole flux tubes which have closed 2-surface (say) spheres as a cross section are not possible in Minkowski space and carry conserved monopole fluxes.

Monopole flux tube have several properties which make them very attractive, not only astrophysically and biologically but in all scales, for instance from the perspective of particle physics.

1. Monopole flux tubes are stable against splitting. U-shaped monopole flux tubes can however split by reconnection which means emission of a closed flux tube. This occurs for instance in solar wind at the night-side of the Earth.

2. Monopole flux tubes form tube networks having physical objects in various scales as nodes. They occur in all scales, including astrophysical and biological scales.

3. The tell-tale signature of the monopole flux fields is that no current is needed to create them. Monopole flux tubes explain the existence of magnetic fields in cosmic scales which would not have been even created since the currents needed to create them are random.

   For instance, Earth's magnetic field is the sum of these two contributions and monopole flux is estimated to be 2/5 of the entire flux. Monopole contribution would be stable and explain why the Earth's magnetic field has not decayed long ago. The monopole part of the Earth's magnetic field plays a key role in TGD inspired quantum biology based on the notion of dark matter as phases of ordinary matter with an effective Planck constant residing at the magnetic body of the system.

4. Monopole flux tubes are the key building bricks of all astrophysical structures in the TGD Universe, in particular solar magnetic fields, and are actually directly visible. Dark matter and energy would be associated with cosmic strings (not those of gauge theories), which have 2-D string world sheet as cross section and 2-D complex manifold of CP_2, $saysphere, asaCP_2projection.Theyc$

The reconnections of the monopole flux tubes would be natural candidates for a fast reconnection for which the Maxwellian model was proposed. Do the TGD view and the Maxwellian view exclude each other or could they be parts of the same story?

The reconnection of a U-shaped flux tube for which parallel portions carry opposite currents requires a pinch of the flux tube so that flux tube portions can touch each other. Ampere's law states that current wires carrying parallel currents attract each other. Could it explain the pinch? One can imagine two mechanisms.

1. The current along the U-shaped flux tube is conserved unless there is a temporary accumulation of electric charge. The absence of charge accumulation implies that the net currents along parallel portions are opposite and repel each other. However, if charge accumulation takes place, the currents can become locally parallel and this could cause the attraction and pinch. The interesting question is what could cause the local charge accumulation.

2. One can also consider a geometric mechanism in which the second portion of the U-shaped flux tubes turns temporarily backwards and the portion in which current runs parallel to the current in the unaffected portion comes near to it so that an attractive force causing the pinch is generated and U-shaped flux tube pair emits a closed flux tube.

3. In the TGD framework, quantum tunneling in macroscopic length scales as a pair of "big" state function reductions (BSFRs) reversing the arrow of time temporarily is suggestive. Suppose that in the initial situation there are two U-shaped flux tubes associated with the two molecules and currents are steady and conserved except during the reconnection period.

   Reconnection of the two U-shaped flux loops would give rise to a pair of monopole flux tubes of opposite magnetic fluxes connecting the two objects, say biomolecules. In this conformation parallel currents flow along the flux tubes. It is assume that the charges at the different flux tubes form Cooper pairs.

   Supra current induces an accumulation of net charges of opposite sign at the ends of the flux tube pair. Supra current cannot however flow forever. Charge saturation occurs and the supra current goes to zero. In this situation reconnection back to U-shaped flux loops can take place. This state is not superconducting since individual charges at the flux tubes flow in opposite directions and cannot form Cooper pairs. Therefore the splitting of Cooper pairs and reconnection would occur simultaneously. BSFR would correspond to a phase transition between super-conducting and non-superconducting states. This phase transition would be a basic mechanism of bio-catalysis.

2.3.3 TGD based model for the solar magnetic field

What can one guess about the structure of the MB consisting of monopole flux tubes (and possibly also sheets)?

1. Only the Maxwellian magnetic field at QFT limit obtained by replacing many-sheeted space-time with a slightly curved Einsteinian space-time surface with 4-D M^4 is directly accessible to the experiments. These fields are known only in the region outside the solar surface. This leaves a lot of freedom.

   A guideline comes from the notion of magnetic bubble [L20] playing a key role in the TGD inspired model for the formation of astrophysical structures as explosive processes. Magnetic bubbles consist of monopole flux tubes at a 2-D surface, such as a sphere. By fractality, one expects that the model should work also in the case of solar flares, which also involve explosions.

2. The magnetic bubble with $\hbar_{eff} = \hbar_{gr}$ a spaghetti of monopole flux tubes with a shape of 2-D closed surface. It would be emitted in an explosive process liberating dark matter and energy. Dark matter would be transformed to ordinary matter and liberate energy.

   A good guess is that the solar surface carries this kind of spherical layer consisting of closed monopole flux loops. The inner parts of monopole flux loops would be along the solar surface and fixed with it. The outer parts of the flux loops would extend to outer space and bound the shape of a moon crescent. This shape would be an outcome of centrifugal force which would be compensated by the force due to string tension.

3. The rotation of the outer parts of the flux tubes is not rigid body motion with a constant angular velocity. The motion is slower than rigid body rotation and this gives rise to a differential rotation in which the angular velocity at the equator is smallest. This affects the shape of the flux tube so that it becomes spiral-like. The lag is largest at the equator.

   String tension of the flux tube opposes this motion and eventually the situation becomes critical for the reconnections when the flux tube portions carrying opposite fluxes and located near the equator are close enough. This reconnection process is associated with the formation of solar spots. This leads to a transformation of the outer part of the flux tube so that it becomes parallel to the solar surface.

   By freezing, the spiral structure for the current sheet should conform with the structure of the magnetic field in the Maxwellian picture obtained at the QFT limit. In TGD, the assumption that currents flow along monopole flux tubes implies this if the Maxwellian flux tubes are parallel to the monopole flux tubes. In this case the freezing would occur for the entire magnetic field.

2.3.4 A general view of the solar flare as a reconnection process

1. In TGD the reconnection is replaced with a topological reconnection for monopole flux tubes and their Maxwellian counterparts.

2. Reconnection at the equatorial current sheet eventually occurs for twisted flux tubes and the outer part of the flux tube decays by emitting small flux loops. Solar flares would accompany this process. Huge magnetic and volume energies could be liberated if the flux tubes are thickened in the phase transition. Twisted flux loops are transformed by the emission of loops to non-twisted dipole loops with strands parallel to the solar surface.

   In this process charged dark particles with very high energies leak out from the flux tubes. No acceleration mechanism is needed. This mechanism could also explain cosmic rays with ultrahigh energies without a need for acceleration mechanisms. Monopole flux tubes can also carry electric fields parallel to them and this could accelerate the charged particles to very high energies since dissipation is absent or very small due to the large value of $\hbar_{gr}$.

3. This picture allows us to also understand the presence of the current sheet. It would be associated with the Maxwellian part of the magnetic field at equator where the fluxes of neighboring portions of the flux tube are opposite and reconnections occur.

The Maxwellian flux tubes could be parallel to the monopole flux tubes and the current sheet would be associated with them if Maxwell's equations hold true approximately as they would at the QFT limit of the TGD. This limit is obtained by replacing the sheets of the many-sheeted space-time with single metrically deformed region of M^4 such that gravitational field *resp.* gauge potentials are identified as sums of deviations of induce metric from M^4 metric *resp.* induce gauge potentials.

2.3.5 How the reconnection process could lead to a reversal of the polarity

How the reconnection process could lead to the reversal of the polarity.

1. The flip of the polarity of the solar magnetic field occurs when the activity of the Sun is maximum. The direction of the magnetic flux at the long rectangular monopole flux tubes must change.

   Conserved monopole flux however prevents this. One option is that the rectangular flux tube rotates along its axis by π and permutes inner and outer parts of the flux tube. This cannot be excluded but does not seem plausible since the inner part of the flux tube is fixed.

   The second option is that the closed flux tubes split by a reconnection process into pieces and the short flux loops should flip and by reconnections fuse back to long flux loops with an opposite direction of magnetic flux.

2. The question how the monopole flux tubes carrying opposite fluxes could be generated from the short flux tubes produced by the decay process, looks very difficult to answer in the framework of standard quantum physics. Second law forbids this process.

   Could zero energy ontology (ZEO) come to rescue? In ZEO both arrows of time are possible and the arrow of time is changed in ordinary ("big) state function reduction (BSFR) [L5, L23, L18].

   One has quantum gravitational coherence at the level of gravitational flux tubes. Could BSFR and therefore a time reversal take place at the level of gravitational MB? Could the reconnection of small loops to a long loop in the opposite direction of time somehow correspond to a decay process with a reversed thermodynamic arrow of time. Note that the change of the thermodynamic arrow of time should not be confused with time reflection T as a geometric symmetry.

3. What happens to the magnetic field B when the thermodynamic arrow of time changes? The Maxwellian part of B changes its sign since it is a curl of vector potential A, having as its source the 3-D current j, which behaves like velocity and changes its sign.

   The monopole flux part of B does *not* have j as source and for string-like objects $X^2 \times Y^2 \subset M^4 \times CP_2$ monopole flux changes sign only if the change of the thermodynamic arrow of time involves a complex conjugation in CP_2. It seems that also the induced electric field associated with the deformation of a string-like object changes its sign too in complex conjugation. This means that the charges change sign and therefore also currents. Nothing would happen to B.

   If no complex conjugation occurs for CP_2, monopole fluxes are not affected. However, the minimization of the magnetic interaction energy between long Maxwellian flux loops and short monopole flux loops could force the monopole flux loops to flip. The roles of H and M in the magnetization would be permuted: M would change the direction of H.

4. Could Lazarus effect have an interpretation as a BSFR so that no new CD would be generated? The consistency with the earlier view would require that the arrow of time changes in BSFR but that the moment of the geometric time identified as a correlate of subjective time assigned with the decay process corresponds to the M^4 time coordinate for the intersection of the half-cones. If the sub-CDs of CD located in either half-cone of CD co-move with it in its expansion by discrete scalings so that the M^4 time associated with their mid points flows, this picture is consistent with that discussed in [L23, L18].

Or could Lazarus effect mean a creation of a new CD as an embedding space correlate for a perceptive field of a conscious entity, self [L24, L18]? Ordinary birth could serve as an example of a generation of a new CD.

In the ZEO based interpretation as a BSFR, the interpretation of this process would be as an analog of biological death followed by reincarnation with an opposite arrow of time.

1. In ZEO, the monopole flux tube pair, which has split into short segments, would be the "corpse" of both the previous gravitational MB and the new MB with an opposite arrow of time. The corpse could be seen as the outcome of two aging processes proceeding with opposite arrows of time from geometric future and past and meeting at the moment of the reconnection process, which corresponds to quantum criticality.

2. The outsider would see the death and decay process of the gravitational MB and its miraculous reincarnation to MB with opposite magnetic fluxes. This "Lazarus effect" would be something new as compared to the earlier applications of ZEO. The sunspot cycle could be perhaps seen as an analog of the sleep-wakeup cycle.

3. This picture is very general and living matter provides especially interesting applications since the decay process for the monopole magnetic flux tubes in biological death should induce the decay process of the biochemical structures. Metabolism has two sides: anabolism is the generation of organic molecules carrying metabolic energy taking place in photosynthesis and in the reconstruction of organic molecules from simpler building bricks produced by catabolism liberating metabolic energy and occurring in digestion. Could the anabolism and catabolism be time reversals of each other and reduce to catabolism of monopole flux loops with opposite arrows of thermodynamic time?

2.4 Why the electric currents that should accompany magnetic substorms in the magnetotail are missing?

I found an interesting popular article (see this) telling about the surprising findings associated with the sub-storms of magnetic storms accompanying sunspots in the magnetotail of the Earth. The reconnections were observed and Maxwell's electrodynamics also predicts electric currents associated with them. However, there was no evidence for them.

TGD based view of electromagnetic fields predicts deviations from the Maxwellian view. In TGD, the magnetic field decomposes into two parts. The TGD counterpart of Maxwellian magnetic fields and the monopole flux part is not present in the Maxwellian theory.

1. The Maxwellian part consists of flux tubes with a cross section which has a boundary, say disk. The flux tubes correspond to space-time regions, or space-time sheets as I call them. The Maxwellian part requires currents to create it. At the quantum field theory (QFT) limit of TGD this gives rise to the Maxwellian magnetic fields.

2. The monopole part consists of closed monopole flux tubes, which have a closed 2-surface as cross section and the Maxwellian flux tubes with, say, disk-like cross section. These are not possible in field theories in Minkowski space. Monopole flux part would contribute roughly 2/5 to the total magnetic field strength of Earth at the QFT limit.

   What is important is that the monopole part does not require currents to create it. The monopole part is topologically stable and explains the puzzling existence of the magnetic fields in even cosmic scales and also the maintenance of the Earth's magnetic field. The Maxwellian part decays since the currents creating it dissipate.

Monopole flux tubes carry $h_{eff} \geq h$ phases of ordinary matter behaving like dark matter.

1. These phases solve the missing baryon problem and the increasing fraction of missing baryons during cosmic evolution. The loss of baryons would be due to the gradual generation of effectively dark phases of nucleons (and other particles) with increasing values of effective

Planck constant h_{eff}. h_{eff} has an interpretation as a measure for an algebraic complexity of the space-time region measured by the dimension of the algebraic extension defined by the two polynomials associated with the region of space-time surface considered. A given polynomial with integer or rational coefficients defines an extension of rationals and the extensions associated with two polynomials define an extension containing both extensions. Mathematically, this increase is completely analogous to the unavoidable increase of entropy. This increase of complexity would give to evolution, also biological evolution. Dark matter in this sense plays a key role in the TGD inspired quantum biology.

2. Notice that in TGD, the galactic dark matter is actually dark energy of cosmic strings (extremely thin monopole flux tubes) and of the monopole flux tubes to which they thicken as extremely thin flux tubes. Therefore one should speak of galactic dark energy. The recent discovery of what looks like MOND type gravitational anomaly for distant stars of binaries gives strong support for this view [L25].

Consider now the mystery of the missing currents. No electric currents associated with storm were observed also the signatures of reconnections were observed. Could the magnetopause be dominated by the monopole flux tubes carrying the $h_{eff} \geq h$ phases of ordinary mater behaving like dark matter. The existence of the associated electric currents is not needed to create the monopole magnetic fields. Are electric currents very weak or are they only apparently absent since they are dark? How does magnetotail relate to this? Is it only because the reconnections occur here.

3 Possible applications to the polarity reversal of Earth's magnetic field and to biology

The proposed picture might apply also to the model for the flip of the Earth's magnetic field discussed in [L2]? Magnetic poles wander and this could be understood as a rigid body motion of MB. The polarity flip takes place rather rapidly and could occur BSFR and involve the magnetic catabolism and anabolism of the monopole flux loops. Since the monopole magnetic fields play a central role in the TGD inspired quantum biology, the possible disastrous consequences of this transition challenge the TGD inspired quantum biology.

3.1 Do the reversals of the Earth's magnetic field induce evolutionary leaps?

I received from Zakaria Ameziane a highly interesting question related to the TGD inspired theory of consciousness and quantum biology, in particular self hierarchy and the notion of quantum jump according to TGD, and the role of the Earth's magnetic field in quantum biology. The question went roughly as follows.

"There is an interesting hypothesis which demonstrates that the DMT, by its affinity with UV-B rays, could be produced significantly, endogenously when the electromagnetic fields are reversed. If this hypothesis would prove to be true, could it trigger a new quantum jump?"

The question involve a link to a discussion in DMT Quest discussion group (DMT Quest is an organization, which supports DMT research) in Twitter (`https://rb.gy/sijxt9`). The link is warmly recommended. The discussion was related to the the so-called Stoned Ape Theory of evolution claims that that the transition from Homo erectus to Homo sapiens and the cognitive revolution was caused by the addition of psilocybin mushrooms, specifically the mushroom Psilocybe cubensis, into the human diet around 100,000 years ago. One can also consider alternative forms of this idea.

From the discussion one can pick up the following facts.

1. DMT is often assigned with pineal gland, "third eye" and the seat of the soul, according to Descartes but according to recent views it is present in the entire brain (see ¡A HREF="https://rb.gy/yftalo"¿this¡/A¿). DMT (I have discussed DMT from the TGD point of view in [L3, L8]) is reported to induce a growth of neurons (`https://rb.gy/zx7zsh`).

By its affinity with UV-B rays, DMT could be produced significantly endogenously as magnetic field reversal occurs and the shield provided by the Earth's magnetic field against UV rays is temporarily lost.

2. The latest magnetic reversal occurred 40,000 years ago in the so-called Laschamp event (`https://rb.gy/i35kqa`). Interestingly, Neanderthals disappeared at this time.

3. 40,000 years also corresponds to a time when a large change in the shape of human brain took place [J1] (`https://rb.gy/hcg8ii`). The following excerpt is from the abstract of the article.

   "... Our data show that, 300,000 years ago, brain size in early H. sapiens already fell within the range of present-day humans.

   Brain shape, however, evolved gradually within the H. sapiens lineage, reaching present-day human variation between about 100,000 and 35,000 years ago. This process started only after other key features of craniofacial morphology appeared modern and paralleled the emergence of behavioral modernity as seen from the archeological record.

   Our findings are consistent with important genetic changes affecting early brain development within the H. sapiens lineage since the origin of the species and before the transition to the Later Stone Age and the Upper Paleolithic that mark full behavioral modernity."

4. Relatively recent research indicates that changes in the geomagnetic field of the earth causes genetic and metabolic changes in plants indicating the potential to be a driver of evolution [I2] (`https://rb.gy/mxhq2z`).

These observations inspire the question whether the magnetic reversal could have induced not only a significant growth of neurons in human brains but also an evolutionary jump?

1. Could this effect have occurred at the level of genes, at the level of epigenesis or both? The amazing findings of Levin [I4, I5, I8, I3], discussed from the TGD point of view in [L24], suggest that besides genes, also electromagnetic field patterns assignable to cell groups (not only neuron groups), determine the outcome of morphogenesis via epigenesis and that modifications of these patterns during the embryo stage can dramatically modify the outcome of morphogenesis without any change at the level of genes. What is remarkable is that these changes are inherited.

2. Could the magnetic reversal have induced an inheritable change of the shape and the electromagnetic structure of the brains of developing embryos? Could the increased amount of DMT during the reversal be behind this change? If only a permanent epigenetic change is in question, it might be induced by DMT.

The following summarizes roughly my reply to the question by Zakaria Ameziane. The reply describes first very briefly what self hierarchy and quantum jumps mean inthe TGD framework.

1. Selves can fuse to larger selves by entangling stably. This could occur in both "small" and "big" statefunction reductions (SFRs). In a pair of BSFRs (BSFRs change the arrow of time) and a TGD counterpart of quantum tunnelling takes place this kind of fusion could occur. This would mean an extension of consciousness. Perhaps this happens as the person gradually wakes up. Also the fusion of say visual fields to single visual field could occur in this way. Right and left brain, or rather their magnetic bodies, could also fuse in this way.

2. DMT is assigned with pineal gland, I would tend to see its presence as a prerequisite for a connection to a rather high level of hierarchy of selves, magnetic body corresponding to a rather long length and time scales.

Concerning the finding that something dramatic took place in the evolution of the human brain about 40,000 years ago when also magnetic reversal took place. Catastrophes induce quantum criticality in long scales which in turn could induce evolutionary jumps.

1. I have just developed a model for the change of the magnetic polarity [L20]: the change of the polarity would be associated both in the case of Sun and Earth to a BSFR changing the arrow of time. This process would be like death followed by reincarnation with the opposite arrow of time at the level of the magnetic body (MB). The sequences of reversals would define the analog of a sleep-wakeup cycle on a large scale.

2. BSFR corresponds to quantum criticality: the monopole flux loops of the magnetic body of Earth decay into pieces, change direction and fuse again as required by the magnetic reversal. MB is the boss and this universal mechanism would also induce biological decay after death and re-organization of molecules to a living organism. It would also be behind catabolism and anabolism at molecular level.

3. During the period of BSFR associated with the reversal, the UV radiation from outer space can enter the Earth's surface and induce large genetic and also other kinds of biological changes. A BSFR at the level of MB of Earth inducing the magnetic reversal could have induced a cascade of BSFRs at shorter scales possibly inducing dramatic evolutionary changes.

   In the TGD Universe, the genes do not dictate everything. Also electromagnetic field patterns at the cellular level, both for neurons and ordinary cells, are in a central role in dictating the development of embryos, as Levin's findings demonstrate. Their change would involve epigenetic change [L24]. This point was already discussed.

4. For instance, these BSFRS inducing large changes at the MB of the brain could have increased the probability of the fusion of MBs of say left and right hemispheres to a larger unit, the MB of the entire brain. This would have induced a stronger interaction of right and left hemispheres. The period of time in an entangled, "whole-brainy" state would have significantly increased.

   This might relate to the hypothesis that bicamerality in which right and left hemispheres behaved like independent selves (schizophrenics and young children might be bicamerals) transformed to modern consciousness in which the brain hemisphere tends to behave like a single coherent entity.

5. There is evidence that the magnetic field of Earth is changing right now (`https://rb.gy/penzen`). Could this mean that polarity reversal of the Earth's magnetic field might happen in the not so distant future. An interesting question is what this could mean for our species.

6. The magnetic bodies of Sun and Earth interact and in TGD framework both MBs play a key role in the quantum biology [L15, L14] based on gravitational quantum coherence prevailing in astrophysical scales.

   An interesting question is whether the solar 11+11 year "sleep-awake" cycle of the solar MB could induce periodicies in human behavior, say in social structures. Maybe statisticians could have something to say about this.

3.2 Could geomagnetic reversals and excursions relate to extinctions and collapses of civilizations?

The stimulus for the following considerations came from a new perspective to climate change and other phenomena. They could be argued to reflect the ethical and moral decay of our civilization. Could there be a much deeper reason for these phenomena and could they be unavoidable and implied by the basic physics? To put it provocatively: could our ethical and moral standards correlate with our physical environment in some sense?

Climate warming and other phenomena that cause disorder in the biosphere bring to mind the second law of thermodynamics. Could a deeper explanation be based on the second law of thermodynamics of its generalization. We turn too much ordered energy into dis-ordered energy. Could carbon dioxide emissions be a secondary phenomenon?

I did not take these considerations very seriously because it is difficult to see the reduction to the atomic level. The loss of order also manifests itself in a rather abstract form, for example on a social level as violence and inequality. Recently, however, I saw a mention of a study in

which I claimed that the increase in entropy produced by human energy consumption starts to be significant at the atomic level. Could the decline of civilization have an explanation in terms of a generalization of the second law forced by TGD?

3.2.1 Some interesting observations

There are several interesting observations which have stimulated the ideas to be discussed in the sequel.

1. The Earth's magnetic field is changing rapidly near the poles (see this). Interestingly, global warming is fastest near the poles. It is expected that the direction of the field can change within a very short period of time. The shortest known polarization change has occurred in a year and global polarization reversals can last hundreds of years. Bjarne Lorentz has proposed on basis of correlations between temperature and the strength of the global magnetic field (see this) that the geomagnetic reversal could relate to global warming because it no longer protects the biosphere from cosmic radiation.

   This proposal however forces us to give up the standard view about dynamo mechanism as the origin of the Earth's magnetic field. The dynamo mechanism has severe difficulties: in particular, the magnetic field should have disappeared a long time ago. The TGD view of magnetic fields deviates dramatically from the Maxwellian view and leads to an explanation for the stability of the Earth's magnetic field and also predicts a mechanism for the polarization reversals [L2]. This mechanism has been also applied to the polarization reversals of the solar magnetic field [L22].

   In TGD, the magnetic bodies of ordinary physical systems carry macroscopically quantum coherent phases of matter being able to control the associated systems consisting of ordinary matter. TGD inspired quantum biology relies on this notion. Therefore there are good motivations to ask whether the correlation between the weakening of magnetic field and climate warming could exist.

   Mainstream scientists do not take the proposal seriously (see this) since there seems to be no standard physics mechanism justifying the claim. Also I am personally skeptical about the proposal that standard physics mechanisms could relate global warming and geomagnetic reversal.

2. In the last global reversal of the direction of the magnetic field about 41,000 years ago, the Neanderthals disappeared, although the reversal was short-lived about 250 years. The average period between reversals between long lasting global reversals is 450,000 years. For short lasting global reversals created in excursions, the average period is 10 times shorter, about 45,000 years (see this). There can also be local excursions and the strength and direction of the magnetic field of Earth indeed fluctuates.

3. Callahan have studied magnetic fields around the world [I6, I1] (see this) and noticed that the magnetic field and as a consequence the Schumann resonance can be very weak, for instance in the Near East. There are serious social problems in these areas. Why would the strength of the magnetic field correlate with the coherence the social atmoshere? Could the magnetic field strength correlate with the coherence of collective consciousness?

3.2.2 Could the entropization of field bodies lead to magnetic reversals and excursions explaining extinctions and declines of civilizations

The above considerations lead to the key idea.

1. Magnetic bodies control biomatter in TGD. Specifically, the Earth's magnetic body, which would determine the collective consciousness of the Earth's and also affect the consciousness of living organisms since their magnetic bodies interact with the Earth's magnetic body.The magnetic body of the Sun would be also involved.

2. Could the fundamental cause of the problems of humanity and the biosphere be the increase of entropy at the level of magnetic bodies. The aging magnetic body would be due to

entropization. This mechanism could also explain the aging of biological organisms [L29]. The entropization would lead to a loss of quantum coherence and the magnetic body would gradually lose control over the processes at the level of the biological body. This would eventually lead to a death struggle of the magnetic body and magnetic body.

More concretely, the monopole flux tube pairs of the Earth's magnetic field would split to short flux tubes. Later they could fuse back to flux tubes with a reversed direction of magnetic field. The process would be the same as in the reversal of the solar magnetic field.

As a result, the quantum coherence scales would shorten and the control of the magnetic body over the bio-matter would be lost. Biomatter would be forced to cope without the help of the magnetic body. During sleep a similar situation takes place and during motor activities and sensory input are absent. The decay of the flux tubes can be local or global and the resulting magnetic flux tubes could be long lasting or only temporary.

3. In zero energy ontology (ZEO), the transition period leading to regeneration of the monopole flux tube would correspond to two "big" state function reductions (BSFRs) in macroscopic scale. It can be local or global and also short-term. In BSFR, the magnetic body would lose its consciousness reincarnating with an opposite arrow of time. In the second BSFR it would wake up with the original arrow of time.

4. One life cycle of the Earth's magnetic body would end (or a little more gently, the magnetic Mother Gaia would fall asleep and live in another direction of time). Eventually, a new cycle would begin with a new magnetic field. These cycles are analogous to the counterpart of sunspot cycles with a duration of 11+11 years. Could one think of a year cycle with a period about 45,000 years in which the magnetic field with reverted direction is short lived. For us, it might mean the collapse and rebirth of civilization. One can wonder what our fate in the next reversal is?

5. There are reasons to ask whether our species is approaching extinction. On the other hand, an enormous progress in science and technology is being made at the same time. This paradox applies more generally, as, for example, biologist Jeremy England has observed [I7]. Biological evolution is generally accompanied by an increase in entropy. p-Adic vision about cognition leads to exactly this prediction [L1]. When the p-adic negentropy associated with quantum entanglement as a measure for the amount of conscious information is large, the standard entropy is also large. The smarter we get, the more we produce entropy.

6. Homo sapiens appeared 300,000 years ago. The oldest Neandertal fossils are 430,000 years old. The most recent global and long-lasting direction change, the Brunhes–Matuyama reversal, occurred 780,000 years ago.

   45,000 years is a reasonable estimate for the average period for the magnetic excursions (see this). The last magnetic excursion was 41,000 years ago. The reversal lasted only 250 years but Neanderthals disappeared. Also now, a change in direction is taking place: could it lead to the extinction of our species or at least the destruction of civilization within a few hundred years? If these temporary reversals are periodic, our species would have survived 7 reversals. This gives a cause for optimism. But on the other hand, we are doing our best to destroy our civilization.

Is it possible to estimate time scales for the duration of the magnetic field orientation from basic physics? The durations of the episodes seem random and the durations of the transitions also vary. p-Adic length scale hypothesis suggests that the periods come in powers of two. Surprisingly, also an esoteric view of the evolution of consciousness predicts so called Yuga cycle (see this predicting octaves of the basic period and giving nearly the same quantitative predictions. Period doubling and stochastic resonance, requiring the presence of a periodic perturbation and noise, could explain these characteristics. The first candidate for the periodic perturbation is the period of equinox precession. A better candidate is the orbital period of planet Sedna to which Earth would have monopole flux tube contacts. The noise would be thermal noise due to the aging of the magnetic body of Earth leading to its "death" and reincarnation by magnetic reversal or excursion.

3.3 A concrete model for the geomagnetic reversals and excursions

In the following a concrete model for the mechanism leading to the geomagnetic reversals and global and local excursions will be developed.

3.3.1 Could the period perturbation due to the precession of the equinox or planet Sedna relate to the magnetic reversals and excursions?

One can imagine two candidates for the periodic perturbation related to the magnetic reversals and excursions.

1. The precession of equinox

Could the period of precession of the equinox define the fundamental time scale related to the geomagnetic reversals and excursions?

1. The precession of the equinox means that at the spring equinox the sun's position in relation to the fixed stars of the Milky Way changes very slowly at a rate of 1 degree per 71.6 years, so that the entire 360 degree cycle corresponds to 25,800 years. This corresponds to the precession of the Earth's axis of rotation, i.e. the change of the axis around which the rotation axis rotates (nutation).

2. This phenomenon cannot be explained by the gravitational physics of the solar system, and I have proposed several TGD-based models for it [E4]. Monopole flux tubes connecting the Earth to some external object play a central role in these models. The flux tubes would pass through the Earth via the poles. For the first option they would not be quite straight and would rotate and in this way induce the precession. Another option is that the faraway ends of the flux tube move along a circular orbit and induce the precession.

This raises two questions.

1. Could the orbital period of the object involved with the magneic reversals and excursions relate to the period of 25,800 years for equinox precession somehow.

2. Could the proposed period 45,000 years for the global magnetic excursions (see this) relate to the equinox precession? The equinox period gives as its first sub-octave 51,600 years, which is too long as compared to the period of about 45,000 years of excursions.

2. Could Sedna or/and Planet 9 cause the periodic perturbation?

The trans-Neptunian object Sedna (see this) has an extra-long and unusually elliptical orbit around the Sun ranging between 76 AU and 938 AU. Its rotation period is T= 11,400 years. The emergence of agriculture 11,000 years ago is consistent with the Sedna hypothesis. The first octave of the Sedna period is 22,800 years. The second octave of T is $4T = 45,600$ years and rather near to the proposed period of excursions so that the flux tube connections to Sedna explain them.

Planet 9 (see this), a hypothetical object having a rotation period in the range 9,900-15,400 years and proposed to be a primordial blackhole, could explain the orbital characteristics of Sedna. Its rotation period could coincide with the equinox precession period or with the rotation period of Sedna. Why would Earth be connected to Planet 9 by flux tubes? Could the argued blackhole property of Planet 9 relate to this somehow? Earth would belong to a flux tube network and nothing prevents Earth from having flux tube connections to both Sedna and planet 9, in particular if they have the same rotation periods. Also flux tube connections to an object with rotation period equal to the equinox period are also possible.

By Kepler's laws one has $T^2 = kR^3$, where T and R are the period and radius of the planet and k depends only on the mass of the star. In the Oort cloud there the typical rotation period of a comet is 1000 years and by factor 10 smaller than the time scales considered. Nottale hypothesis [E2], assumed also in TGD [E4], states that planets move along Bohr orbits. The value of the gravitational Planck constant introduced by Nottale is $\hbar_{gr} = GM/\beta_0$. This would give $R \propto n^2$, where n is a principal quantum number for the Bohr orbit.

3.3.2 Could p-adic length scale hypothesis imply a fractal hierarchy of time scales for global and local reversals?

How could the octaves of fundamental period emerge? p-Adic length-scale hypothesis serves as a guideline as one tries to make the proposal quantitative. Preferred harmonics and subharmonics come as octaves of the fundamental period. One can consider two options corresponding to the 25,800-year period for the precession of the equinox and to the rotation period of Sedna as fundamental period.

1. Consider first sub-harmonics. Period doubling is universal in non-linear systems and leads to chaos. A period of 45,000 years for global but short-lived reversals of direction is 10 percent smaller than the period 51,600 years obtained by a period doubling.

   For the Sedna option, the period $4 \times 11,400 = 45,160$ years is rather near to the estimated value for the period estimated for excursions. If one takes this at the face value, the recent change of the direction of the magnetic field could be global. The period 11,600 years could relate to the emergence of agriculture about 11,000 years ago. If this were the case, the next major event in this time scale would be within 600 years. The role of agriculture has been taken over by industry and it may be that this transition is already happening.

2. Harmonics are obtained in any non-linear system. The changes of the direction of magnetic field could be local and seen at the level of individual civilizations and also the transition periods and durations of reversals would be shorter. For the Sedna option the periods would be 11,400, 5,700, 2,850, 1,475, 737.5, 378.8, 189.4, 94.7, 47.35, 23,6, 11,8 ,.. years. Could these periods correspond to biorhythms as harmonics associated with the Sedna rotation period? It would be fascinating if even the time scales assignable to biological organisms and humans could be induced by the flux tube connections to Sedna (and possibly also Planet 9).

3.3.3 Could stochastic resonance be involved?

I have discussed stochastic resonance from the TGD point of view earlier in [**?**] and recently in [L27]. Also the reversal of the stochastic resonance plays a key role in TGD inspired quantum biology.

1. Stochastic resonance appears in bistable systems in presence of a periodic perturbation when the amplitude of the external noise is suitable. The frequency of stochastic resonance equals $f_{spont} = 2f$. f_{spont}, defined as the frequency for the transitions between the two states of the bistable system, is determined by the amplitude of the noise. f_{spont} is proportional to an Arrhenius factor having also interpretation as (quantum) tunnelling probability, whose dependence on the amplitude of the noise is exponential. Also the harmonics nf_{spont} of this frequency are induced but are exponentially damped.

2. In the recent case the two states of the bistable system correspond to the orientations of the Earth's magnetic field. The thermalization of the Earth's magnetic body would cause the noise leading to stochastic resonance inducing the polarization flip. The periodic driving force with period T could be caused by Sedna or equinox precession. The period T_{exc} for excursions would be $T_{exc} = T/2$ or its sub-harmonic.

3. The period $T_{prec} = 25,800$ years for the precession of equinox gives $T_{exc} = 12,400$ years, which might correspond to the period assignable to local reversals of the magnetic field. The absence of a noise with a correct amplitude could cause long periods without reversals and excursions and also the occurrence of only few excursions. The harmonics of f_{spont} would give periods T_{exc}/n and as special case sub-octaves $6,200$ years, $3,100$ years, etc... suggested by the p-adic length scale hypothesis.

4. If the rotation of Sedna defines the periodic perturbation, stochastic resonance gives the period $5,200$ years plus its subharmonics, in particular sub-octaves 2,600 year, etc..

Stochastic resonance cannot explain the proposed excursion period of 45,000 years. Here period doubling, also conforming with the p-adic length scale hypothesis, seems to be the only explanation and applies for both equinox and Sedna option.

3.3.4 Connection with the esoteric world views

There is an interesting connection with esoteric world views. Ville-Einari Saari sent me a link to the article "The Yuga Cycle And The 25,800-Year Precession Cycle Of The Earth" by Bibhu Dev Misra (see this) presents arguments based on what is known about the emergence of civilizations at different parts of the globe.

1. In ancient cultures, it has been believed that consciousness is associated with what could be called the Yuga cycle which has a period of 24,000 years, somewhat shorter than T= 25,800 years for the equinox precession cycle. The ancient cultures were aware of the precession of the equinox. However, it must be taken into account that in these cultures the accuracy of the measurements was at a completely different level, so the difference cannot be considered decisive. The first octave of Edna rotation period 22,800 years.

2. 3 octaves of this period are assumed to be important. The Kali Yuga cycle is divided into two 12,000-year cycles, which are further divided into four 3,000-year cycles with a 300-year transition period. The periods of these 3 cycles of octaves from the basic period. So we would get cycles of 24,00, 12,000, 6000, and 3000 years. The period doubling would give a 48,000 year cycle. These periods are rather near to the periods 22,800 11,400, 5,700, 2,850 years predicted by the Sedna hypothesis.

3. Misra suggests that the 3000-year cycle with a period rather near to 2,850 years is related to the rise and fall of civilizations on a global scale. The civilizations would disappear and regenerate as waves that spread across the globe. This process would be induced by the decay and regeneration of flux tubes at an expanding wave front The transition period, which in TGD would correspond to a time-reversed "sleep" period, would be short, hundreds of years or even shorter.

3.4 Tukdam and TGD

The following considerations were inspired by a TV document (`https://rb.gy/abt8za`) about a strange phenomenon known as Tukdam. What happens is that in Tukdam state the person is physically dead but is believed to be in a continued meditation. There is no EEG, the heart does not beat, and there is no normal metabolism. What is strange is that the decomposition processes do not start. The condition can last up to a couple of weeks. Similar longer-lasting ones have been reported: a yogi can be buried underground for months in an oxygen-free state and then wake up.

Tukdam phenomenon challenges neuroscience's view of the brain as the seat of consciousness. According to reports there could be awareness and a sensory experience consisting of different light sensations. The Tibetan Book of the Dead describes these experiences. Near-death experiences have many similar features.

In the body in Tukdam, the area of the heart is reported to feel warmer to the touch than the rest of the body, but the thermometer does not detect this difference. This would indicate that the body receives metabolic energy at the cellular level from some other source than in the normal metabolism, and that living matter can detect what measuring devices based on the recent knowledge provided by modern physics cannot detect.

Where could this energy come from? If one wants to answer this, one must also ask what happens in death and what is consciousness and what is life.

1. Dark energy and matter are the two basic puzzles of recent day physics. In the TGD approach, dark matter is identified as phases of ordinary matter, for which the effective Planck constant h_{eff} is much larger than normally. In particular, the Planck constant $h_{eff} = h_{br}$ characterizing gravitational flux tubes can be very large and makes quantum coherence possible even on astrophysical scales. Large Planck constants would be associated with the dark matter magnetic body, which would be the TGD counterpart to the magnetic field of Maxwell's theory, but would differ from it in many respects. As a quantum coherent unit, this magnetic body would control the ordinary biological body and induce its coherence. The classical energy of a magnetic body, consisting of volume energy and magnetic energy, would be dark energy.

2. In the TGD Universe dominated by zero energy ontology, consciousness is a universal phenomenon and present on all scales, from elementary particles to the level of the cosmos. Even galaxies, stars and planets would be conscious beings. Also life and death would be universal phenomena. Likewise, the biological decomposition process associated with death would correspond to the universal decomposition process, which would essentially correspond to the decomposition of magnetic monopole flux tubes (magnetic catabolism), which would induce the catabolism of the breakdown of biomolecules. Its time-reversed version would be magnetic anabolism and induce the building of bio-structures such as molecules.

3. The reversal of the Sun's magnetic field would correspond to magnetic catabolism as the breakdown of long monopole flux tubes into very short parts. It would be followed by magnetic anabolism as their re-fusion into long flux tubes. The solar cycle would correspond to the sleep-wake cycle, or more precisely: a series of lives in different directions of time. Death would only be a change of time's arrow, nothing final.

4. The fundamental metabolic processes would be basically magnetic anabolism and catabolism induced by "big" state function reductions changing the arrow of time and inducing the biological anabolism and catabolism. Death would mean reincarnation with the opposite arrow of time.

In Tukdam, the biological body would be dead, but the magnetic body would still be alive and prevent the biological decay from starting. The disintegration of the magnetic body as a reconnection process splitting monopole flux tubes to pieces in the way described above would start in Tukdam much later than normally, and initiate the disintegration of the biological body. The contents of the conscious experience in Tukdam, light sensations and deep peace, would come from the magnetic body. The dead biological body would not provide contribution from sensory input, motor activity, and cognition.

4 Geomagnetic reversals and excursions and the anomaly of equinox precession from the TGD point of view

The field body (magnetic [L21, L22, L14] or electric [L16]) is a key notion of TGD inspired quantum biology. It carries macroscopic quantum phases as phases of ordinary matter with effective Planck constant h_{eff}. In particular, gravitational and electric Planck constants assignable to the classical gravitational and electromagnetic fields can have a very large value. As a consequence, the field body serves as the "boss" of the ordinary biological body. The aging of the field body leads to the thermalization of the dark matter associated with it and would lead to the loss of control over the biological body. Eventually this could lead to the biological death [L29].

4.1 Background ideas and questions

4.1.1 Cosmic strings and the anomalous precession of equinox

I have discussed the TGD based model for equinox precession in [E4]. The model to be discussed is an updated version of this model reflecting the progress of TGD occurred after the first version of the model was developed.

The cosmic strings, whose thickenings give rise to monopole flux tubes, explain the flat velocity spectrum for distant stars rotating galaxies. Also the cosmic strings connecting stars could have distant planets rotating them. The anomalous behavior of planet Sedna and also of comets in the Oort cloud could be understood if Sedna rotates around a cosmic string connecting Sun or a PS and carrying a very strong magnetic field B_{S-SP}. The spin axis of the Earth could correspond to the axis connecting Sun and the PS.

There are two candidates for the PS: Vega and Stellar Polaris. The periodicity of the motion of Vega is same as the periodicity of equinox percession so that remains a unique candidate.

The gravitational force between the cosmic string and solar system and objects rotating the cosmic string would modify the local direction of the cosmic string at the Earth and therefore contribute to the equinox precession besides the gravitational torque due to the Sun and Moon.

Also a magnetic torque between the monopole flux tubes of B_E and of B_{S-SP} would be generated by the objects rotating around the cosmic string and Sun and would tend to change the direction of B_E.

4.1.2 Could equinox precession correlate with the reversals and excursions of the Earth's magnetic field?

The basic idea of the TGD based model [L2] for the reversals and excursions of the Earth's magnetic field B_E is that monopole part of B_E occasionally makes a reversal and in this way refreshes the Maxwellian of B_E which decays due to the decay of Ohmic currents in time scale of about 20,000 years.

The average periods between excursions are of the same order of magnitude as the period of equinox precession. Could the time varying magnetic torque between the monopole flux tubes of B_E and B_{S-SP} facilitate the magnetic reversals and even excursions. Stochastic resonance, occurring when the level of the noise is correct, could be a possible dynamical mechanism .

4.1.3 Could the excursions and reversals of B_E together with the aging of the magnetic body of Earth induce extinctions and collapses of civilizations?

The stimulus for writing this article came from a new perspective to climate change and other phenomena. They could be argued to reflect the ethical and moral decay of our civilization. Could there be a much deeper reason for these phenomena and could they be unavoidable and implied by the basic physics? To put it provocatively: could our ethical and moral standards correlate with our physical environment in some sense? Could extinctions and collapses of civilizations reflect the aging of the magnetic body of Earth leading eventually to the decay of the magnetic body and re-organization to a new magnetic body with reversed orientation of B_E.

4.2 A TGD based view for the anomaly of the equinox precession

4.2.1 Precession of equinox

The prediction for the period of precession of the equinox is too short which suggests that some new physics is involved.

1. The precession of the equinox means that at the spring equinox the sun's position in relation to the fixed stars of the Milky Way changes very slowly at a rate of 1 degree per 71.6 years, so that the entire 360 degree cycle corresponds to 25,800 years. This corresponds to the precession of the Earth's axis of rotation, i.e. the change of the axis around which the rotation axis rotates (nutation).

2. This phenomenon cannot be explained by the gravitational physics of the solar system, and I have consider several TGD-based models for it [E4]. Monopole flux tubes connecting the Earth to the PS play a central role in these models. The flux tubes would pass through the Earth via the poles.

   One can imagine several options. The simplest option is that the direction of the flux tubes connecting the Sun to the PS defines the spin axis of the Earth. The precession of the flux tube axis would force the precession of the Earth's spin axis. The second option is that a local variation of the flux tube direction at the Earth induces the precession of the spin axis. The gravitational forces of the objects rotating the string cond affects its direction locally at the Earth. These effects alone could explain the precession in the radical option. For the conservative option they would contribute an additional effect to the effects caused by the Sun and Moon.

4.2.2 Some observations and questions

The precession problem involves three directions.

1. Pole Star (PS) is by a definition a star above the North pole. Stellar Polaris with distance 433-448 light years satisfies this definition. Vega was a PS in 12,000 years BCE and will be PS in 13,727. The period of Vega is in 1 percent accuracy the same as for the equinox precession. This motivates a milder definition of PS is that it is periodically a PS and will be used in the sequel. The Sun-PS axis is a physically significant direction if the cosmic string(s) or monopole flux tube(s) connecting these two stars defines the direction of the Earth's rotation axis.

2. The direction of the Earth's magnetic field B_E defined by the dipole moment in the dipole model is also an important direction. The recent direction of the monopole flux tubes of the Earth's magnetic field is rather near to the direction of the Sun-Stellar Polaris axis. The magnetic axis is a local notion since the B_E is not pure dipole field. The tilt angle of the magnetix axis with respect with to the spin axis varies with time and position.

3. How parallel is the axis of the Earth's magnetic field B_E to the precessing spin axis? Is the tilt angle between B_E and North defined by the direction to Vega slowly varying? At this moment the opening angle of the precession cone is 23.5 degrees. The varying tilt angle of B_E is estimated to be 11 degrees and is slightly smaller than half of the opening angle, that is 12.25 degrees. This would suggest that B_E is almost parallel to the Sun-Vega axis. Do the flux tubes of B_E roughly define the axis around which the precession takes place. Is the angle between the axes of PS and B_E 2.5 degrees?

Continental drift brings in an additional complexity since it implies that the position of the North Pole in the geological sense is dynamical. The regions near recent Poles have once been tropical regions. If the magnetization of various magnetic materials in the direction of B_E in various geological layers has been frozen to the permanently magnetized objects and if only the continental drift has changed the orientations of these objects, allows us to reconstruct the history for the direction of B_E in the coordinate system defined by the Stellar Polaris.

4.2.3 Could a cosmic string connecting the Sun and Vega induce the equinox precession?

Sun and Moon give a rather satisfactory but far from complete description of the equinox precession but several additional periodic perturbations would be involved with the equinox precession. The actual period of 25,800 years is longer than the predicted period of 24,000 years. The computational models cannot predict the behavior of the precession for long time spans. Some new elements are involved. In [E4] it was asked whether the precession of the orbital plane of the entire solar system could be in question and it was proposed that monopole flux tubes could be in question. The recent model is an updated version of this model.

Cosmic strings with a high string tension solve the problem of galactic dark matter and provide the TGD counterpart for inflation generating ordinary matter from the energy of cosmic strings. Cosmic strings and thickened flux tubes could be a new actor also in astrophysics. The basic prediction is that cosmic strings or magnetic flux tubes with a smaller string tension can connect stars and other astrophysical objects. Planets and perhaps even stars can form bound states with the cosmic strings connecting stars.

This motivates the question whether the cosmic strings and objects orbiting around the cosmic string connecting Sun and Vega, could relate the equinox precession. There are two views: radical and conservative.

1. The radical view considered already in [E4] is that the equinox precession is due to the change of the orientation of the spin axis defined by the cosmic string connecting the Sun and PS. This suggests that the spin axis of the Earth is nearly orthogonal to the ecliptic plane at which the planets orbiting the Sun are.

   At this moment the instanenous tilt angle of the spin axis with respect to ecliptic is 23.44 degrees whereas the opening angle of the precession cone is 23.5 degrees at this moment. The tilt angle has been in te range 22.0-24.5 degrees during the last 5 million years so that it seems to be an appproximate constant of motion. This conforms with the assumption that the ecliptic plane precesses and its normal direction is defined by the flux tubes connecting

the Sun to Vega. The periodic motion would induce the precession of the normal direction of the ecliptic plane and the direction of the spin axis of the Earth with respect to the ecliptic.

This precession would not be rigid body precession but reflect the presumably elliptic orbit of Vega. If the direction of the North is permanently defined by Stellar Polaris, this proposal fails. For the Vega option, the recent North is however predicted to be in the direction of Stellar Polaris so that one cannot draw this conclusion. If the observed precession is the precession of the spin axis relative to the elliptic, this proposal might work. If not, then the equality of the two periods forces us to consider the possibility that the motion of Vega somehow induces a rigid body precession around the direction of Stellar Polaris. The large distance of Vega leaves under consideration only an effect somehow caused by the cosmic string connection.

2. The conservative view is that objects orbiting the cosmic string could cause an additional torque on Earth if it is attached to the cosmic string (being analogous to a local flux tube tangle). One also expects that there are monopole flux tubes connecting Earth to these objects since all astrophysical objects should appear as nodes of a network of cosmic strings.

   (a) Since very distant objects cause a negligible torque on ordinary astrophysical objects, the torque should affect the cosmic string from the Sun to PS to which the Earth would be attached. The cosmic string, and the Earth with it, would experience the $1/\rho$ gravitational force caused by the objects rotating the string and tending to change the direction of the string at Earth. This would change the direction of the rotation axis of the Earth if it is parallel to the string and cause the equinox precession.

   (b) The conservative view about the equinox precession would look like follows. The period of equinox precession is $T = 25,800$ y. The gravitation of the Sun and Moon gives a good estimate of 24,000 years for T. Sedna's and possible other objects rotating the cosmic string connecting Sun and PS contribute an additional gravitational force on the cosmic string and change its direction at Earth if it is attached to the cosmic string. This would change the rotation axis parallel to the cosmic string. This would spoil the periodicity and could make the average period longer.

Vega and Stella Polaris are the two candidates for the PS to which the Sun would be connected by monopole flux tubes and whose direction axis could determine to a high degree the direction of the instantaneous spin axis of the Earth. The distance of the Stella Polaris is between 323-423 light years so that the direction of the monopole flux tubes to it should be essentially constant. Also their existence looks implausible. Vega is therefore a more plausible candidate.

1. Vega is .5 billion years old and located at a distance of about 25 light years whereas the Sun is thought to be about 4.6 billion years old. Vega is the brightest star near the Sun. Sun and Vega are thought to have condensed simultaneously from a proto disk. This could explain the flux tube connections between the Sun and Vega.

2. The declination of Vega, defined as the angular distance from the equator of Earth, was $\delta = +86$ degrees 4 minutes 12,000 BCE when Vega was the PS in a strong sense. The declination of Vega is now $\delta_{now} = 38$ degrees 47 minutes 01.2802 seconds now (2024) and will be the same as 12,000 years BCE in year 13,727. From this the period of for the variation of δ is 25,727 years, which equals with a one per cent accuracy to the period of equinox precession of about 25,800 years. This makes Vega a unique candidate. The equinox precession could be caused essentially by the precession of the direction of the flux tubes connecting Sun and Vega. The radical option would be therefore correct.

3. Now Stella Polaris is the PS and 14,024 years have passed $\delta = 0$ so that Vega has passed the middle point of the cycle corresponding to 12,863 years. This conforms with the fact that Stellar Polaris is now the PS and suggests that the declination of the Vega varies between $\delta = 0$ and maximum value larger than the recent value and should be decreasing now.

The cautious conclusion is that the flux tube connections to Vega cause the precession of equinox.

4.2.4 Could the objects orbiting a cosmic string connecting Sun and Vega allow us to understand the anomalous behavior of Sedna and Oort cloud?

The cosmic string connection between the Sun and Vega would bring a completely new element to astrophysics of the solar system, possibly explaining various anomalies. One can imagine several candidates for the objects orbiting around the cosmic string connecting the Sun to the Vega and having Earth attached to it.

1. The trans-Neptunian object Sedna (see this) has an extra-long and unusually elliptical orbit around the Sun ranging between 76 AU and 938 AU. Its rotation period is T= 11,400 years. The inclination of Sedna is 11 degrees so that the magnetic field of Earth would be nearly orthogonal to its orbital plane around the cosmic string. This would conform with the assumption that the orbital plane of the Sedna has the Sun-Vega axis as a normal. The very strange orbital characteristics of Sedna could be due to the fact that it rotates around the cosmic string connecting the Sun and PS.

2. The strange behavior of comets in the Oort cloud involves a large increase of the number of comets visiting the inner Solar System with a consequential increase of impact events on Earth. The visit of Sedna near the Sun could catch the comets temporarily on orbits in the orbital plane of Sedna. The periodic visits of Sedna in the inner solar system could induce effects also at the level of civilization.

3. Planet 9 (see this) is a hypothetical object assumed to have semimajor axis of 100 AU and a rotation period in the range 9,900-15,400 years. Planet 9 is proposed to be a primordial blackhole, has been proposed to explain the orbital characteristics of Sedna. Its rotation period is of the same order of magnitude as with the equinox precession period and the rotation period of Sedna and it could rotate around the cosmic string connecting Sun and Vega. Planet 9 is not needed to explain the behavior of Sedna if Sedna rotates around the cosmic string connecting Sun and Vega.

4. Nemesis, "death star", is a hypothetical red dwarf or brown dwarf with mass $.005M_{Sun}$ originally postulated in 1984 to be orbiting the Sun at a distance of about 95,000 AU (1.5 light-years) and somewhat beyond the Oort cloud. This distance is considerably smaller than the distance 25 light years of Vega. The proposal was that Nemesis could explain a perceived cycle of mass extinctions in the geological record, which seem to occur more often at intervals of 26 million years. In a 2017 paper, Sarah Sadavoy and Steven Stahler argued that the Sun was probably part of a binary system at the time of its formation, leading them to suggest "there probably was a Nemesis, a long time ago". Such a star would have separated from this binary system over four billion years ago, meaning it could not be responsible for the more recent perceived cycle of mass extinctions. The proposed explanation of equinox precession gives this role to Vega.

   Nemesis would be at a highly elliptical orbit that periodically disturbs comets in the Oort cloud, causing a large increase of the number of comets visiting the inner Solar System with a consequential increase of impact events on Earth. This became known as the "Nemesis" or "Death Star" hypothesis. The period of mass extinctions is 28 million years and very long as compared to the period of Sedna. The period of 28 million years of Nemesis is about 254 times longer than the period 11,400 years of Nemesis and has about 16 longer orbital radius.

   The hypothetical Nemesis could move along a very elliptic orbit around the Sun-Vega cosmic string made natural by the logarithmically varying gravitational potential of the string. It could deviate the orbits of comets in the Oort cloud so that they visit the Sun. They would orbit around the cosmic string in the orbital plane of Nemesis during the visits. The orbital planes for Sun and hypothetical Nemesis have angle, which corresponds to the angle between magnetic field and rotation axis of Earth, and is therefore consistent with the assumption that the string connects Sun and PS.

4.2.5 Orbits around cosmic string/monopole flux and a possible problem with the gravitational Planck constant

A helical pair of flux tubes forming a flattened closed flux tube could be taken as the model of for the string like entity connecting Sun and PS. The strands of the U-shaped closed flux tube could be rather distant.

1. Classical model

Stringy gravitational potential v_{gr} is logaritmic, that is of form $V_{gr} = mv_{gr} = klog(\rho/\rho_0)$ and and very slowly varying. This allows very elliptical orbits. Energy $E = m\epsilon$ and angular momentum $L = ml$ are conserved and this allows too solve the equations of motion. Half Period can be exressed as a generalization of elliptic integral.

$$T = \int_{\rho_{min}}^{\rho_{max}} d\rho \frac{1}{\sqrt{\epsilon - v_{gr} - l^2/\rho^2}} \quad .$$

Here one has $l = m\rho\omega$. Turning points ρ_{min} and ρ_{max} correspond to the radii at which the quantity $\epsilon - v_{gr} - l^2/\rho^2$ vanishes. Circular orbits are obtained as a special case and for these velocity is constant $v = \sqrt{TG}$ irrespective of the radius and in the case of distant stars of galaxies.

2. Quantum model

The quantization of angular momentum is not quite straightforward. Nottale's quantization condition does not make sense for infinitely long string like objects since the mass is infinite. One an howewer ask whether the approximation as an object of effective finite length could work. At least for closed strings of length L, say DNA like helical pairs of strings, which are actually single strings turning back this should work. Only a finite portion of string defined in a natural way, for instance as a string connecting two ordinary astrophysical objects would be taken into account.

1. The string does is closed and finite length L. If the radius R of the orbit is considerably smaller than L approximation as straight infinitely long string is reasonable. But does the quantization condition allow this kind of situation which are physically possible (galactic dark matter and cosmic strings)

2. Nottale's gravitational constant $hbar_{gr} = GMm/\beta_0$. The parameter $\beta = \sqrt{TG}$ gives a good estimate for β_0.

   One must approximate the string so that it has finite length L. Double helical string for instance. A natural identification of L would be as the length of the string portion connecting two astrophysical objects. One would have $M = TL$, where T is the string tension which is reduced for the flux tubes.

3. Consider the quantization of antular momentum for an object rotating the string. Mass m disappears from the condition. Also $\beta \equiv TG$ disappears from the condition and one obtains

   $$R\beta = n\frac{GM}{\beta_0} = \frac{nTGL}{\beta_0} = n\frac{\beta L}{\beta_0}.$$

   This gives

   $$\frac{R}{L} n \frac{\beta}{\beta_0} \quad .$$

   One should have $R/L < 1$. This is not possible except for $n < \beta/\beta_0$. For $L \sim 300ly$ associated with Sun-PS string and $R \sim .007$ ly associated with Sedna one should have $\beta/beta_0 < 10^{-5}$. The string one should have $\beta = \sqrt{TG} < 10^{-5}$. From other considerations, $\beta = TG$ has an upper bound in the range $10^{-6} - 10^{-7}$ [L21]. The string in question could be even cosmic string.

4.3 TGD based view of geomagnetic reversals and excursions

I have discussed a model [L2] for what occurs in the geomagnetic reversals based on idea that the stable part of the Earth's magnetic field consisting of monopole flux tubes changes its orientation and in this way generates ohmic currents refreshing the Maxwellian part identifiable as magnetization. A slightly updated model of this view will be discussed first. In this model the dynamics of B_E would not involve external influences.

4.3.1 An updated view of the model for the maintenance of the magnetic field of the Earth

The basic problem of the dynamo model is that the time scale for the decay of ohmic currents generating the Earth's magnetic field in the dynamo model is about 20,000 years to be compared with the average period 45,000 years between excursions. The average period between reversals is 450,000 years.

The TGD view of magnetic fields deviates dramatically from the Maxwellian view and leads to an explanation for the stability of the Earth's magnetic field and also predicts a mechanism for the polarization reversals [L2].

1. The key prediction is that the magnetic field contains a stable component consisting of closed monopole flux tubes not present in the Maxwellian world. The monopole flux loops could flow along the Earth's surface and return from the South pole to the North pole along North-South-axis or, more plausibly, parallel to the Earth's surface as assumed in the case of the Solar magnetic field. The presence of the monopole flux tubes generates the Maxwellian component by magnetization whereas in the dynamo mechanism the currents in the core of the Earth generate the magnetic field.

2. The orientation reversal for the flux tubes could involve a temporary decay of the closed monopole flux tubes by reconnections to short loops which then reconnect to flux tubes with opposite polarization. This kind of decay would be associated with the polarization reversals of the solar magnetic field [L22]. In Mars, the reconnection would have failed so that it would have lost the monopole component of the magnetic field in the planetary scale.

3. The reversed monopole flux component would generate magnetization refreshing the Maxwellian component. The excursions and reversals and essentially randomly but the average period 45,000 years for the excursions has the same order of magnitude as the estimated lifetime of ohmic currents assumed to generate the magnetic field in the dynamo model. The average period between the reversals leading to a longlasting change of the polarity is 45,000 years.

The magnetic flux tubes with the monopole component change their polarity in excursions and reversals. What could cause these events? Materialist would require that the reversal should have a purely mechanistic explanation. TGD however forces to consider a different explanations.

1. These events would occur when the Maxwellian component of B_E produced by the magnetization becomes too weak. Could one say that the monopole component takes care that the Maxwellian component is not lost. This would conform with the idea that the magnetic body of the Earth is a conscious intelligent entity, which controls the biosphere.

2. An alternative explanation, more in line with the materialistic thinking, generalizes the proposal for biological aging as a thermalization of the magnetic body [L29]. As the temperature at the monopole flux tubes increases, their geometry develops random fluctuation and they thicken so that the magnetic field strength weakens.

   As a consequence, reconnections of the flux tubes become probable and lead to the decay to short flux loops as a magnetic counterpart of biological death. After that they would reconnect back to flux tubes with opposite magnetic polarizations. In zero energy ontology (ZEO) the decay and fusion would correspond to a pair of "big" state function reductions (BSFRs) involving changed arrow of time.

   Note that the reduction of entropy in these two BSFRs involving also the Maxwellian part of the magnetic field should reduce the entropy of both components of the magnetic field

(consisting of flux tubes). The interpretation of a period of sleep as a period of opposite arrow of geometric time and involving a pair of BSFRs helps to understand the reduction of entropy. Sleep indeed has a healing effect.

Why should the magnetic polarization be opposite for the reincarnated monopole flux tubes? What could change the orientation of the short flux tube fragments before they fuse to long flux tubes? Or could it be that it need not change always: the events in which does not occur would be non-events as far as magnetic field is considered?

In TGD, the magnetic bodies of ordinary physical systems carry macroscopically quantum coherent phases of matter being able to control the associated systems consisting of ordinary matter. TGD inspired quantum biology relies on this notion. Therefore there are good motivations to ask whether the correlation between the weakening of the magnetic field and even phenomena like climate warming could exist.

4.3.2 Could the magnetic torque between the monopole flux tubes of B_E and Sun-Vega cosmic string induce magnetic reversals?

The proposed model for the magnetic reversals and excursions does not consider possible external influences inducing them.

The updated model for the equinox precession involves in an essential manner the cosmic strings connecting the Earth to Vega (this) defining the direction of the spin axis of Earth. This axis does not quite coincide with the magnetic axis of Earth.

Could the magnetic torque between the magnetic flux tubes of the Earth's magnetic field and the magnetic field of monopole flux in the direction of the Vega define the periodic driving forces inducing stochastic resonance if the noise level is correct? The model for the reversals of the solar magnetic field [L26, L22] involve the decay of the monopole flux tubes to loops followed by a fusion to flux tubes with opposite magnetic polarity. Also in the recent case the decay is necessary. This makes the process probabilistic so that it is characterized by the probability for the change of the polarity in fusion.

If the noise level is correct for a half of all cases, the flip of the magnetic polarization occurs for half the cases and the average period would be two times the period of equinox precession that is 51,600 years. The average period is 45,000 years if the probability for the excursion is $p \simeq .43$. The magnetic reversals with a period of 450,000 years might be caused by a similar mechanism.

4.3.3 Could stochastic resonance be involved?

I have discussed stochastic resonance from the TGD point of view earlier in [**?**] and recently in [L27]. Also the reversal of the stochastic resonance plays a key role in TGD inspired quantum biology. The following arguments suggest that stochastic resonance cannot relate the magnetic excursions to equinox precession.

1. Stochastic resonance appears in bistable systems in presence of a periodic perturbation when the amplitude of the external noise is suitable. The frequency of stochastic resonance equals $f_{spont} = 2f$. f_{spont}, defined as the frequency for the transitions between the two states of the bistable system, is determined by the amplitude of the noise. f_{spont} is proportional to an Arrhenius factor having also interpretation as (quantum) tunnelling probability, whose dependence on the amplitude of the noise is exponential. Also the harmonics nf_{spont} of this frequency are induced but are exponentially damped.

2. In the recent case the two states of the bistable system correspond to the orientations of the Earth's magnetic field. The thermalization of the Earth's magnetic body could cause the noise leading to stochastic resonance inducing the polarization flip. The periodic driving force with period T could be caused by Sedna or equinox precession. The period T_{exc} for excursions would be $T_{exc} = T/2$ or its sub-harmonic.

3. The periodic driving force would be the magnetic torque between the monopole flux tubes of the Earth's magnetic field (or magnetic dipole characterizing it) and the monopole flux tubes connecting the Earth to Vega defining the direction of the Earth's temporary spin axis. This

force would vary periodically and could cause the spin flip if the condition for the stochastic resonance is satisfied. Also other periodic perturbation due to the objects rotating around the Sun-Stellar Polaris cosmic string would be involved. The problem with the stochastic resonance is that the period would be one half of the period of precession: that is 12,400 years.

4. If the stochastic resonance is involved, this would suggest local shortlasting reversals of B_E not reported. The absence of a noise with a correct amplitude could cause long periods without reversals and excursions and also the occurrence of only few excursions. The harmonics of f_{spont} would give periods T_{exc}/n and as special case sub-octaves $6,200$ years, $3,100$ years, etc... suggested by the p-adic length scale hypothesis.

   If the rotation of Sedna defines the periodic perturbation, stochastic resonance gives the period $5,200$ years plus its subharmonics, in particular sub-octaves with period 2,600 year, etc...

4.4 Could magnetic reversals and excursions relate to extinctions and declines of civilizations?

The stimulus for the writing of this article came from a new perspective to climate change and other phenomena, which can be argued to reflect the ethical and moral decay of our civilization. Could there be a much deeper reason for these phenomena and could they be unavoidable and implied by the basic physics? To put it provocatively: could basic physics correlate with our ethical and moral standards?

Climate warming and other phenomena that cause disorder in the biosphere bring to mind the second law of thermodynamics. Could a deeper explanation be based on the second law of thermodynamics of its generalization. We turn too much ordered energy into dis-ordered energy. Could carbon dioxide emissions be a secondary phenomenon?

I did not take these considerations very seriously because it is difficult to see the reduction to the atomic level. The loss of order also manifests itself in a rather abstract form, for example on a social level as violence and inequality. Recently, however, I saw a mention of a study in which I claimed that the increase in entropy produced by human energy consumption starts to be significant at the atomic level. Could the decline of civilization have an explanation in terms of a generalization of the second law forced by TGD?

4.4.1 Some interesting observations

There are several interesting observations which have stimulated the ideas to be discussed in the sequel.

1. The Earth's magnetic field is changing rapidly near the poles (see this). Interestingly, global warming is fastest near the poles. It is expected that the direction of the field can change within a very short period of time. The shortest known polarization change has occurred in a year and global polarization reversals can last hundreds of years. Bjarne Lorentz has proposed on basis of correlations between temperature and the strength of the global magnetic field (see this) that the geomagnetic reversal could relate to global warming because it no longer protects the biosphere from cosmic radiation.

   This proposal however challenges the standard view about dynamo mechanism as the origin of the Earth's magnetic field. The dynamo mechanism (see this) however has severe difficulties: in particular, a simple estimate (see this) suggests that the magnetic field should disappear in about 20,000 years. The magnetic field changes its direction in eccurions which on the average take place with a period 45,000 years and in reversals occurring with a period of 450,000 years.

   Mainstream scientists do not take proposal seriously (see this) since there no standard physics mechanism justifying the claim seems to exist. Also I am personally skeptical about the proposal that standard physics mechanisms could explain global warming and geomagnetic reversal and in the following I willd considere a much deeper level explanation based on TGD inspired theory of consciousness and quantum biology. The problems of human kind could

be due to the aging of the magnetic body of Earth so that it is no more able to control the biosphere.

2. In the last global reversal of the direction of the magnetic field about 41,000 years ago, the Neanderthals disappeared, although the reversal was short-lived about 250 years. The average period between reversals between long lasting global reversals is 450,000 years. For short lasting global reversals created in excursions, the average period is 10 times shorter, about 45,000 years (see this). There can also be local excursions and the strength and direction of the magnetic field of Earth indeed fluctuates.

3. Callahan have studied magnetic fields around the world [I6, I1] (see this) and noticed that the magnetic field and as a consequence the Schumann resonance can be very weak, for instance in the Near East. There are serious social problems in these areas. Why would the strength of the magnetic field correlate with the coherence the social atmoshere? Could the magnetic field strength correlate with the coherence of collective consciousness?

4.4.2 Could the entropization of field bodies facilitate magnetic reversals and excursions and relate to extinctions and declines of civilizations?

The above considerations lead to the key idea.

1. Magnetic bodies control the biomatter in the TGD Universe [L21, L22]. Specifically, the Earth's gravitational magnetic body, which would determine the collective consciousness of the Earth's and also affect the consciousness of living organisms since their magnetic bodies interact with the Earth's magnetic body. The gravitational magnetic body of the Sun would be also involved [L17, **?**].

2. Could the fundamental cause of the problems of humanity and the biosphere be the increase of entropy at the level of magnetic bodies. The aging magnetic body would be due to entropization. This mechanism could also explain the aging of biological organisms [L29]. The entropization would lead to a loss of quantum coherence and the magnetic body would gradually lose control over the processes at the level of the biological body. This would eventually lead to a death struggle of the magnetic body and magnetic body.

   More concretely, the monopole flux tube pairs of the Earth's magnetic field would split to short flux tubes. Later they could fuse back to flux tubes with a reversed direction of magnetic field. The process would be the same as in the reversal of the solar magnetic field.

   As a result, the quantum coherence scales would shorten and the control of the magnetic body over the bio-matter would be lost. Biomatter would be forced to cope without the help of the magnetic body. During sleep a similar situation takes place and during motor activities and sensory input are absent. The decay of the flux tubes can be local or global and the resulting magnetic flux tubes could be long lasting or only temporary.

3. In zero energy ontology (ZEO), the transition period leading to regeneration of the monopole flux tube would correspond to two "big" state function reductions (BSFRs) in macroscopic scale. It can be local or global and also short-term. In BSFR, the magnetic body would lose its consciousness reincarnating with an opposite arrow of time. In the second BSFR it would wake up with the original arrow of time.

4. One life cycle of the Earth's magnetic body would end (or a little more gently, the magnetic Mother Gaia would fall asleep and live in another direction of time). Eventually, a new cycle would begin with a new magnetic field. These cycles are analogous to the counterpart of sunspot cycles with a duration of 11+11 years. Could one think of a year cycle with a period about 45,000 years in which the magnetic field with reverted direction is short lived. For us, it might mean the collapse and rebirth of civilization. One can wonder what our fate in the next reversal is?

5. There are reasons to ask whether our species is approaching extinction. On the other hand, an enormous progress in science and technology is being made at the same time. This paradox applies more generally, as, for example, biologist Jeremy England has observed [I7].

Biological evolution is generally accompanied by an increase in entropy. p-Adic vision about cognition leads to exactly this prediction [L1]. When the p-adic negentropy associated with quantum entanglement as a measure for the amount of conscious information is large, the standard entropy is also large. The smarter we get, the more we produce entropy.

6. Homo sapiens appeared 300,000 years ago. The oldest Neandertal fossils are 430,000 years old. The most recent global and long-lasting direction change, the Brunhes Matuyama reversal, occurred 780,000 years ago.

   The periods between magnetic reversals and excursions seem to be random. 45,000 years is a reasonable estimate for the average period for the magnetic excursions (see this). The last magnetic excursion was 41,000 years ago. The reversal lasted only 250 years but Neanderthals disappeared. Also now, a change in direction is taking place: could it lead to the extinction of our species or at least the destruction of civilization within a few hundred years? If recursions are periodic, our species would have survived 7 recursions. This gives a cause for optimism.

5 Summary and outlook

This article was inspired by a single puzzling astrophysical observation but was extended by further similar observations. The discussion of these findings allowed us to develop a TGD based vision about the generation of astrophysical structures to a much more detailed level. This vision should apply also to other interactions.

The foregoing discussion suggests that the dynamics of gravitational fields could reduce to the dynamics of flux tubes subject to the conservation of total Kähler electric fluxes, which have a definite sign.

The topological dynamics would be essentially re-organization of the network formed by electric flux quanta as nodes of the network connected to each other by flux tubes, which can also carry Kähler electric flux. Twistor lift of TGD and $M^8 - H$ duality [L6, L7] led to a rather similar picture for the scattering amplitudes [L12, L13] in terms of fundamental fermions.

This generalizes also to the dynamics of gauge fields. Flux tubes can be characterized by the value of h_{eff} characterizing a given interaction, and the notion of gravitational Planck constant generalizes to all interactions. The key physical idea is that Nature is theoretician friendly: if quantum coherence is to be preserved, a phase transition replacing the ordinary Planck constant $\hbar$ with $\hbar_{eff}$ must take place, when the interaction strength $Q_1Q_2/4\pi\hbar$ becomes too large for the perturbation series to converge. The alternative option is that the system decomposes to coherent subunits such that the perturbation series converges for them. This means a reduction of quantum coherence scale.

The understanding of atomic and molecular physics at the space-time level has been a long-standing challenge of TGD.

1. I have proposed that $h_{eff} > h$ for the valence bonds as flux tubes could allow us to gain insights about the periodic table [L28]. Monopole flux tubes can also carry ordinary electric fluxes and this would allow us to understand the recent empirical findings about chemical bonds as carriers of electric flux [L9]. TGD also suggests a flux tube model for hydrogen bonds. Also a generalization of hydrogen and valence bonds involving quantum gravitation in the TGD sense [L14] can be considered so that quantum gravitation would define an essential part of biochemistry.

2. What about atoms in TGD Universe? The proposed description for the gravitational interaction at the level planetary system in terms of flux tubes could generalize almost as such to a description of electromagnetic interactions at the atomic level. The U-shaped flux tube pairs with opposite magnetic charges and carrying electromagnetic flux besides monopole magnetic flux would emanate from protons and connect them to electrons. For a pair of opposite charged particles, the U-shaped flux tubes would be closed. For ions the flux tube pair would continue outside the atom. The flux tubes of a given atom could also form flux tube bundles. Also linking and knotting are possible for the flux tubes so that the capacity for topological quantum computation emerges.

3. A powerful restriction comes from the condition that monopole flux tubes must be closed. The proposal is that they are U-shaped and form pairs of flux tubes connecting two systems. This does not require that the Kähler electric charges of the members are opposite. For gravitational flux tube pairs they are of the same sign. For gauge interactions they are of the same sign but the sign can vary.

There are many topics related to flux tubes, which are not considered in this article.

1. TGD predicts homologically non-trivial flux tubes: in the simplest situation $X^4 = X^2 \times S^2$, the CP_2 projection S^2 is a homologically trivial geodesic sphere. If they are allowed by the preferred extremal property, they would serve as natural correlates for the Maxwellian magnetic fields. One cannot exclude flux tubes with light-like boundaries, and they would be even more natural counterparts for Maxwellian fluxes.

   In the standard terminology of condensed matter physics [L10], they would correspond to the magnetization M, whereas the monopole part of the measured magnetic field, which needs no currents as its sources, would correspond to the magnetizing "external" field H, which can be said to control M (and possibly containing $h_{eff} = h$ phases). The presence of monopole fluzes allows us to understand the puzzle posed by the fact the magnetic field of Earth is non-vanishing although dissipation of currents implies the decay of the Maxwellian part.

2. Interesting questions relate to the many-sheeted space-time. Monopole fluxes can flow between two space-time sheets through wormhole contacts. Elementary particles have wormhole contacts as building bricks [L11] [**?**, **?**]. Can one separate this level from the levels just discussed. For instance, can one consider closed flux loops travelling through several sheets in long length scales as the hierarchy of Planck constants would suggest.

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