Exploration

New Findings Related to the Chiral Selection

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Abstract

The article "Enantioselective Adsorption on Magnetic Surfaces" of Mohammad Reza Safari et al published in the journal Advanced Materials (2023) discusses very interesting findings related to the chiral selection. There is a copper conductor with a strong electric field in the normal direction of the conductor. Cu is not a magnetic substance. There are very thin Cobalt islands at the surface of the conductor. Cobalt is a magnetic metal. There are two options: magnetization direction is North or South and it corresponds to either up or down. North up and South down are the options and these could correspond to different chiralities somehow. The molecules drift to the Cobalt islands and, depending on their chirality, prefer to bind to either south-up or north-up Cobalt islands. Are the magnetic fields of islands helical and possess a definite chirality? Does the magnetic chirality tend to be the same or opposite to that of the enantiomer that binds to it? The effect is reported to occur already before the Cobalt islands in the drifting of molecules to the Cobalt islands. Counterparts of magnetic fields are not present outside the Cobalt islands. It is also found that electrons with a given spin direction prefer to tunnel through the molecules in a direction which correlates with the chirality. Chiral selection is a mystery in standard model physics since it represents huge parity violation. TGD suggests a mechanism of parity violation in terms of the hierarchy of effective Planck constants labelling phases behaving like dark matter. For a large enough value of h_{eff}, the dark weak boson Compton length would be a biological scale and below this scale the parity violation would be large. This motivates a concrete model for what occurs in the experimental situation. The model provides support for the generalizations of Pollack effect and dark genetic code replacing dark protons with dark electrons.

1 Introduction

I learned of very interesting empirical findings related to the chiral selection of biomolecules (see the popular article). The article "Enantioselective Adsorption on Magnetic Surfaces" of Mohammad Reza Safari et al [2] is published in the journal Advanced Materials (2023).

1.1 The findings

Consider first the experimental arrangement and findings.

1. There is a copper conductor with a strong electric field in the normal direction of the conductor. Cu is not a magnetic substance. There are very thin Cobalt islands at the surface of the conductor. Cobalt is a magnetic metal. There are two options: magnetization direction is North or South and it corresponds to either up or down. North up and South down are the options and these could correspond to different chiralities somehow.

2. The molecules drift to the Cobalt islands and, depending on their chirality, prefer to bind to either south-up or north-up Cobalt islands. Are the magnetic fields of islands helical and possess a definite chirality? Does the magnetic chirality tend to be the same or opposite to that of the enantiomer that binds to it?

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3. The effect is reported to occur already before the Cobalt islands in the drifting of molecules to the Cobalt islands. What does this mean? Counterparts of magnetic fields are not present.

4. It is also found that electrons with a given spin direction prefer to tunnel through the molecules in a direction which correlates with the chirality.

Chiral selection is a mystery in standard model physics since the it represents huge parity violation. TGD suggests a mechanism of parity violation in terms of the hierarchy of effective Planck constants labelling phases behaving like dark matter. For a large enough value of h_{eff}, the dark weak boson Compton length would be a biological scale and below this scale the parity violation would be large. This motivates a concrete model for what occurs in the experimental situation. The model provides support for the generalizations of Pollack effect and dark genetic code replacing dark protons with dark electrons.

2 TGD based model for the findings

In the sequel, the general ideas about chiral selection in the TGD Universe are discussed and at the end a concrete model is proposed.

2.1 The general TGD view of the findings

These findings are provide new empirical hints about the nature of chiral selection in living matter. Weak interactions are indeed weak and parity violation effects should be extremely small above weak scale so that the standard model fails to explain chiral selection.

1. Chiral selection is one of the key empirical facts supporting the TGD prediction of a hierarchy of phases of ordinary matter predicted by the number theoretical vision of TGD [20, 19, 29, 23, 24, 25]. These phases are labelled by effective Planck constant h_{eff}, which is essentially the dimension of an algebraic extension of rationals.

2. The predicted huge values of h_{eff} assignable to classical gravitational and electric fields of astrophysical objects [25] mean that weak interactions become as strong as em interactions below the scale up Compton length of weak bosons, which, being proportional to h_{eff}, can be as large as cell size. This amplifies parity violation effects visible for instance in hydrodynamics [6].

3. Large h_{eff} phases behave like dark matter: they do not however explain the galactic dark matter, which in the TGD framework is dark energy assignable to cosmic strings (no halo and an automatic prediction of the flat velocity spectrum). Instead, large h_{eff} phases solve the missing baryon problem. The density of baryons has decreased in cosmic evolution (having biological evolution as a particular aspect) and the explanation is that evolution as unavoidable increase of algebraic complexity measured by h_{eff} has transformed them to $h_{eff} \geq h$ phases at the magnetic bodies (thickened cosmic string world sheets, 4-D objects), in particular those involved with living matter.

4. The large value of h_{eff} has besides number theoretical interpretation [21, 22, 26, 27] also a geometric interpretation. Space-time surface can be regarded as many-sheeted over both M^4 and CP_2. In the first case the CP_2 coordinates are many-valued functions of M^4 coordinates. In the latter case M^4 coordinates are many-valued functions of CP_2 coordinates so that QFT type description fails. This case is highly interesting in the case of quantum biology. Since a connected space-time surface defines the quantum coherence region, an ensemble of, say, monopole flux tubes can define a quantum coherent region in the latter case: one simply has an analog of Bose-Einstein condensate of monopole flux tubes.

The flux tube condensate as a covering of CP_2 means a dramatic deviation from the QFT picture and is a central notion in the applications of quantum TGD to biology. Therefore some examples are in order.

1. Fermi liquid description of electrons relies on the notion of a quasiparticle as an electron plus excitations of various kinds created by its propagation in the lattice. In some systems this description fails and these systems would. have a natural description in terms of space-time surfaces which are multiple coverings of CP_2, say flux tube condensates.

2. In high Tc superconductors and bio-superconductors [10, 11] the space-time surface could correspond to this kind of flux tube condensates and Cooper pairs would be fermion pairs with members at separate flux tubes. The connectedness of the space-time surface having about $h_{eff}/h = n$ flux tubes would correlate the fermions.

3. Bogoliubov quasiparticles related to superconductors are regarded as superpositions of electron excitation and hole. The problem is that they have an ill-defined fermion number. In TGD, they would correspond to superpositions of a dark electron accompanied by a hole which it has left behind and therefore having a well-defined fermion number. Bogoliubov quasiparticle is indeed what can be seen using the existing experimental tools and physical understanding.

4. Strange metals would be an example of a system having no description using quasiparticles, as the linear dependence of the resistance at low temperatures demonstrates. I have considered a description of them in terms of Cooper pairs at short closed flux tubes [10, 15]: this would however suggest a vanishing resistance in an ideal situation. Something seems to go wrong.

   An alternative description could be in terms of superpositions of dark electrons and holes assignable to the flux tube condensate. Strange metal is between Fermi liquid and superconductor: this conforms with the fact that strange metals are quantum critical systems. The transition to high Tc superconductivity is preceded by a transition to a phase in which something resembling Cooper pairs is present.

   A natural looking interpretation would be in terms of a flux tube condensate and pairs of dark and ordinary electrons. Also now the flux tubes could be short. In [8], I have considered the possibility that high Tc superconductors could be this kind of ”half-superconductors” but this option seems to be wrong.

   The phase transitions between ”half-superconductivity” and superconductivity could play a central rol also in living matter.

2.2 How large parity violation could emerge in the TGD framework

Before proceeding to a detailed model, one must understand how the large parity violation required by the chiral selection could emerge in the TGD framework.

1. Since the Kähler action does not contain the induced $SU(2)_L$ weak fields, there should be no direct parity violation at the space-time level. The geometric parity violation as a chiral selection of biomolecules could be however induced from the fermionic dynamics induced by the modified Dirac action determined completely the bosonic action. The twistor lift of TGD [16, 13, 7] suggest that this action is a sum of volume term and Kähler action.

   Holography realized as generalized holomorphy implies that solutions are minimal surfaces irrespective of action and only the conditions at boundaries and singularities distinguish between different general coordinate invariant actions constructible using the induced geometry.

2. In the standard physics framework one could argue that Chern-Simons term relates to the parity violation. Now the situation is not so straightforward since parity violation for the weak interactions basically occurs at the level of $M^4 \times CP_2$ and is induced to the space-time level.

   Chern-Simons-Kähler (CSK) action emerges from the topological istanton term $J \wedge J$ in the exponent defining vacuum functional [9, 12, 14, 18]. The CSK term is naturally imaginary whereas the non-topological term defining the Kähler function as Kähler action would be real. The CSK term contains two parts corresponding to M^4 and CP_2 parts of the Kähler form. Neither Kähler action nor CSK action contain the induced $SU(2)_L$ gauge potentials so that parity violation directly induced by weak interactions is not present. CSK action is associated with partonic orbits carrying fermion lines identified as the light-like boundaries of the space-time surface and the interfaces of Euclidean and Minkowskian regions of the space-time surface.

3. CSK term contributes also a term to the modified Dirac action [18] [28], which is fixed completely by the bosonic action defining the space-time surfaces as a Bohr orbit-like preferred extremals satisfying holography, which reduces to a generalized holomorphy [14].

   What is crucial is that the covariant derivative acting on the induced spinor fields, obtained by restricting the second quantized H spinor fields to the space-time surface, contains the parity violation weak interaction term so that the parity violation at the level of elementary fermions emerges through it. This parity violation must induce the geometric parity violation at the level of the geometry of space-time surfaces distinguishing between different chiralities in dark weak scales.

4. The model of anomalous electron-positron pairs produced in heavy nucleus collisions [17] assigns dark leptopion condensate to the non-vanishing of the Chern-Simons term requiring that the induced Kähler and electric fields are not orthogonal. The condition that the dark leptopion Compton wavelength, which is 1/2 of dark electron Compton length, should be of the order of the thickness of the electric flux tube. One must assume that the leptopions are dark in the sense that they have $h_{eff} \neq h$ since otherwise they would be produced in the decays of weak bosons.

It will be found that the model provides further support for a generalization of the Pollack effect [3, 1, 5, 4]: instead of protons of water molecules, electrons at the conductor surface would be transformed to dark electrons at the magnetic monopole flux tubes. This suggests also a generalization of the dark genetic code discussed already earlier [24]. For this generalization dark proton triplets as a representation of codons would be replaced with dark electron triplets. The universality of the realization of the dark genetic code in terms of the completely unique icosa tetrahedral tessellation of hyperbolic space H^3 supports this idea.

2.3 A concrete TGD based model for the findings

Consider now a concrete model for the findings in the TGD framework.

1. A good guess is that the molecular monopole flux tubes of the molecules and of the magnetic fields assignable with the Cobalt islands tend to have the same chirality. This would generalize the chiral selection from the level of biomolecules to the level of dark monopole flux tubes. Some kind of condensate of flux tubes of the same chirality as a long scale parity violation would be in question.

2. In the TGD framework, the North up and South up magnetic fields could correspond to helical monopole flux tubes of opposite chiralities. The helical structure is essential and could relate directly to the requirement that the flux tube is closed: one could have a shape of flattened square for which the long sides form a double helix. This would be the case also for DNA.

3. Parity violation requires a large value of h_{eff}. Dark Z (and W) bosons could generate a large parity violation. Dark Z boson Compton length of order biological scale. The very large value of h_{eff} would give the needed large energy splitting between generalized cyclotron energies at the dark flux tube and induce chiral selection.

   Gravitational flux tubes of the Earth's gravitational field or solar gravitational field would do the job. By the Equivalence Principle, the gravitational Compton length $\Lambda_{gr,E} = .5$ cm for Earth does not depend on the particle mass and looks like a promising scale. Also the cyclotron energies are independent of the mass of the charged particle since $\hbar_{gr}$ is proportional to particle mass m and cyclotron frequency to $1/m$.

4. Also the electric field of the Copper surface should have an important role. The electric field orthogonal to Cu conductor would correspond to electric flux tubes. The consistency condition for the electric flux tube thickness with charged at the bottom (conductor) reads as $\Lambda_{em}(d) \sim d$. $\hbar_{em} = Ne^2/\beta_0$, N the number of electrons at the bottom. There is roughly one electron per atom. $N \sim 10^4$ per flux tube area of 100 nm^2 having radius about 10 nm. $\Lambda_{em} = Ne^2/\beta_0\lambda_e$ is about 1 nm for $\beta_0 = 1$. The value of $\hbar_{em}$ are rather small and it seems that it cannot contribute to the chiral selection. One can however consider also the electric field of Earth, and in this case the situation could be different.

The effect occurs already before the Cobalt islands. Furthermore, electrons with a given spin direction prefer to tunnel through the molecules in a direction dicrated by the chirality. What could this mean?

1. The counterparts of magnetic fields are present as dark magnetic fields inside the magnetic bodies of the drifting molecules. Suppose that dark molecular gravitational monopole tubes are indeed present and give rise to closed spin current loops with a direction determined by the chirality of the molecule. This would give rise to the large parity violation but how to understand the occurrence of the effect already before the Cobalt islands?

2. Could one assign a definite chirality also to the electric flux tubes assignable to the Cu surface and assume that the molecular chirality tends to be the same (or opposite) to this chirality? Do also these closed monopole flux tubes carry dark electric current?

   The spin direction of the current carrying electrons would correlate with the magnetization direction so that the magnetic body of the molecule would prefer a pairing with the electric body with a preferred spin direction. The preferred pairing would explain the drift to a correct Cobalt island: the paths leading to the Cobalt island would be more probable.

3. In the case of water, the Pollack effect [3, 1, 5, 4] transfers part of the protons of water molecules to dark protons at monopole flux tubes. Now there are no protons available.

   Does this require a generalization of the Pollack effect? Could the electric flux tubes be gravitational flux tubes carrying electrons instead of protons? Gravitational Compton length would be the same. Could electronic Pollack effect for conductors as a dual of Pollack effect for water be in question.

4. In the TGD inspired quantum biology, one assigns genetic code with dark proton triplets. Could one assign a dark realization of the genetic code to dark electron triplets? Could the electric counterparts of gravitational flux tubes carrying dark realization of the genetic code define dark genetic code? Codons would correspond to dark electron triplets instead of dark proton triplets. Could the analogs of the ordinary genetic codons correspond to the triplets of electron holes at the conductor surface?

   The TGD based vision about universal genetic code suggests the existence of a 2-D analog of DNA realized in terms of mathematically completely unique hyperbolic icosa tetrahedral tessellation. Could this genetic code be associated with the metal surfaces? The implications of this hidden genetic code for computers might be rather dramatic.

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