Teslaphoresis and TGD

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Abstract

The recently discovered phenomenon of Teslaphoresis might involve new physics. Tesla studied systems critical against di-electric breakdown and observed strange electrical discharges occurring in very long length scales. Colleagues decided that these phenomena have mere entertainment value and are "understood" in Maxwellian electrodynamics. The amateurs have however continued the experiments of Tesla, and Teslaphoresis could be the final proof that something genuinely new is involved.

In TGD framework these long ranged strange phenomena could correspond in TGD quantum criticality and to large values of Planck constant implying quantum coherence in long length scales. The phases of ordinary matter with non-standard value $h_{eff} = n \times h$ of Planck constant would correspond to dark matter in TGD framework. I have earlier considered Tesla's findings from TGD point of view and my personal opinion has been that Tesla might have been the first experimenter to detect dark matter in TGD sense. Teslaphoresis gives further support for this proposal.

In this article the TGD counterparts for the Maxwellian em fields involved with Tesla coils are considered in TGD framework and it is found that many-sheetedness of space-time is necessary to understand the standing waves also involved. The fact that massless extremals (MEs) can carry light-like currents is essential for modelline currents classically using many-sheeted space-time. The presence of magnetic monopole flux tubes distinguishing TGD from Maxwellian theory is suggestive and could explain why Teslaphoresis occurs in so long length scales and why it induces self-organization phenomena for CNTs. The situation can be seen as a special case of more general situation encountered in TGD based model of living matter.

1 Introduction

I found an interesting popular article about a recently discovered phenomenon christened Teslaphoresis [D1] (see http://tinyurl.com/htyaf4h). This phenomenon might involve new physics.

Tesla studied systems critical against di-electric breakdown and observed strange electrical discharges occurring in very long length scales. Colleagues decided that these phenomena have mere entertainment value and are "understood" in Maxwellian electrodynamics. The amateurs have however continued the experiments of Tesla, and Teslaphoresis could be the final proof that something genuinely new is involved.

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The title of the popular article is "Reconfigured Tesla coil aligns, electrifies materials from a distance" tells about the effects involved. The research group is led by Paul Churukuri and there is also an abstract about the work in ADS Nano journal [D1] (see `http://tinyurl.com/z3qybx2`). This article contains also an excellent illustration allowing to understand both the Tesla coil and the magnetic and electric fields involved. The abstract of the paper provides a summary about the results.

This paper introduces Teslaphoresis, the directed motion and self-assembly of matter by a Tesla coil, and studies this electrokinetic phenomenon using single-walled carbon nanotubes (CNTs). Conventional directed self-assembly of matter using electric fields has been restricted to small scale structures, but with Teslaphoresis, we exceed this limitation by using the Tesla coil's antenna to create a gradient high-voltage force field that projects into free space. CNTs placed within the Teslaphoretic (TEP) field polarize and self-assemble into wires that span from the nanoscale to the macroscale, the longest thus far being 15 cm. We show that the TEP field not only directs the self-assembly of long nanotube wires at remote distances ($\geq$ 30 cm) but can also wirelessly power nanotube-based LED circuits. Furthermore, individualized CNTs self-organize to form long parallel arrays with high fidelity alignment to the TEP field. Thus, Teslaphoresis is effective for directed self-assembly from the bottom-up to the macroscale.

To sum up: what is found that single-walled carbon nanotubes (CNTs) polarise and self-assemble along the electric fields created by capacitor in much longer length scales than expected. Biological applications (involving linear molecules like microtubules) come in mind. CNTs tend to also move towards the capacitance of the secondary coil of the Tesla coil (TC).

I this article the TGD counterparts for the Maxwellian em fields involved with Tesla coils are considered in TGD framework and it is found that many-sheetedness of space-time is necessary to understand the standing waves also involved. The fact that massless extremals (MEs) can carry light-like currents is essential for modelling currents classically using many-sheeted space-time. The presence of magnetic monopole flux tubes distinguishing TGD from Maxwellian theory is suggestive and could explain why Teslaphoresis occurs in so long length scales and why it induces self-organization phenomena for CNTs. The situation can be seen as a special case of more general situation encountered in TGD based model of living matter.

2   What Tesla coils are?

Wikipedia contains a nice description of Tesla coils (`https://en.wikipedia.org/wiki/Tesla_coil`). Also the abstract (see `http://tinyurl.com/z3qybx2`) provides an illustration about the Tesla coil used.

Harmonic oscillator serves as an indispensable mechanical analogy for time dependent voltage source $V(t)$ and components (L, C, R) coupled in series to forma closed circuir. The dynamics is governed by differential equation

$$L\frac{d^2 I}{dt^2} + R\frac{dI}{dt} + \frac{I}{C} = dV_{ext}(t) \ \ . \tag{2.1}$$

Here L inductance (associated with coils in the illustration) with LdI/dt telling the voltage between ends of the inductance coil, C is the capacitance associated with the metal torus telling the charge of the capacitor ($Q = CV$) in potential V relative to the ground. Also relative capacitance

with ground replaced with metal object in constant potential and V with the voltage between the two makes sense. IR is the contribution to the voltage of the circuit. V_{ext} is the external voltage. The mechanical analogy corresponds to $(I, L, C, R, dV_{ext}/dt) \leftrightarrow (x, m, 1/k, K, F_{ext})$ where (x, m, k, K, F_{ext}) are the position, mass force constant, friction, and external force applied on the harmonic oscillator.

The circuit consists of three parts (see http://tinyurl.com/hetyaac).

1. The first part has in parallel inductance L_0 and AC source characterized by voltage amplitude V_0 and frequency f acting as external driving force. L_0 corresponds to the outer coil in the figure of abstract.

2. The primary circuit has inductance $L_{1,1}$ and capacitance C_1 in series in the situation in which di-electric breakdown has not taken place so that the current switch defined by the air gap is off. There is also internal resistance R_1, not included to the illustration. In the simplest model for the situation the voltage U_1 relates to U_0 by $U_1/U_0 = N_2/N_1$, where N_2 and N_1 are in numbers of windings for the two coils. On the other hand, one has $U_1 = Q_1/C_1$ equal to $(N_2/N_1)U_1$.

   When the value of the electric field associated with U_1 exceeds critical value (in the range 5-30 kV/m) dielectric breakdown takes place and the current starts to run in the entire primary circuit $(L_{1,2}, R_1, C_1)$ and induces via the coil $L_{1,2}$ a current in secondary circuit (L_2, R_2, C_2). $L_{1,1}$ corresponds in the illustration of the article to a tunable inductance and L_2 corresponds to the inner cylindrical coil. C_2 corresponds to the sum of the stray capacitance of L_2 and capacitance C_2 of the metal torus.

   The circuits $(L_{1,1}, L_{1,2}, R_1 C_1)$ and (L_2, R_2, C_2) are chosen so that their resonance frequencies are the same and equal to the input frequency to achieve resonance. The frequencies are in radio frequency range and according to Wikipedia article vary in the range 50 kHz to 1 MHz. The duration of the on-period much longer than the corresponding time scales.

   What happens during the on-period is that capacitor C_2 develops oscillating charge and oscillating electric field orthogonal to the capacitor at its surface. Also oscillating magnetic field is induced: here the possible current along the electric field lines affects the situation. Also at this dielectric breakdowns can occur of the local electric field near the C_2 exceeds critical value.

The discovery is that the radial oscillating electric fields induces what is christened as Teslaphoresis (for more general phenomenon of dielectrophoresis see http://tinyurl.com/hgj645q)). What is seen as surprising is that the phenomenon takes place in length scales longer than 30 cm. The wavelengths of the AC photons vary in the range [124 m , 6 km]. The fact that Tesla managed to produce this kind of strange phenomena in a length scale of entire town suggests that the wavelength of the radio waves is the key scale, perhaps quantum scale.

CNTs polarize and self-organize along the field lines of the electric field involved. CTNs can also self organize to form a wiring between LEDs and extract energy from the fields of TC so that the LEDs shine. This would be a partial fulfilment of Tesla's dream about wireless energy transfer. If the length scale involved is that of radio waves, the dream might be realized in rather long scales. Also the tractor effect is observed: CNTs are attracted towards TC along electric field lines. This can be understood if they develop polarization parallel to the electric field of the capacitor C_2.

3 How TGD could be involved?

My earlier attempts to understand what happened in Tesla's circuits [K4, K1] inspired the question whether some new physics could be involved. The presence of effects in unexpectedly long length scales raises the question whether quantum criticality and the hierarchy of Planck constants could be involved. The conjecture has indeed been that quantum criticality leads to a generation of phases of ordinary matter with non-standard value $h_{eff} = n \times h$ of Planck constant and thus quantum coherence in length scales scaled up by factor n from what they are usually [?]. Dielectric breakdown is a critical phenomenon and an essential part of the functioning of TC. The test for

the hypothesis is to look whether the effects disappear when the coupling between primary and secondary is not by dielectric breakdown.

Radio wavelengths are used. The experience from quantum biological models [**?**]ncourages to ask whether the photons become dark at quantum criticality and whether their energies $E = h_{eff} \times f$ are above thermal energy. TGD inspired quantum biology would suggests that the energies could be in visible and UV range just as bio-photons identified as decay products of dark photons. Large energy of dark radiowave photons would make possible effective energy transfer along long distances. The transformation of dark photons to ordinary photons would generate energetic photons and could serve as a signature of the effect analogous to bio-photons. The self-organization of CNTs along electric field line should involve macroscopic quantum coherence.

The modelling of time varying electromagnetic fields involves open questions in TGD framework. Consider first the available building bricks [K3, K2].

1. The imbedding of any em field locally is possible but the imbeddability to CP_2 implies topological field quantization, which is reasonably well understood for static fields. The preferred extremal property reflecting strong form of holography implying effective 2-dimensionality poses further powerful constraints at the level of single space-time sheet so that extremely restricted repertoire of field patterns is expected to be possible.

   At the level of many-sheeted space-time the situation is different. The Maxwellian limit of TGD is obtained by replacing the sheets of many-sheeted space-time with single region of Minkowski space and by summing induced gauge potentials at various sheets (test particle experiences touching space-time sheets experiences the sum of gauge potentials and induced gravitational field identified as sum CP_2 parts of the induced metric).

2. There are excellent reasons to assume that cosmic string solutions $X^2 \times Y^2$ with X^2 minimal surface in M^4 and Y^2 a homologically non-trivial complex surface of CP_2 allow deformations to magnetic flux tubes having 4-D CP_2 projection. One can make Lorentz boosts for the magnetic flux tubes and together with many-sheetedness this makes possible complex repertoire of moving quasi-stationary fields patterns at Maxwellian limit.

3. Deformations of CP_2 type vacuum extremals provide description of Euclidian space-time regions identified as lines of generalized Feynman diagrams. The light-like 3-D boundaries between Minkowskian and Euclidian space-time regions having degenerate 4-metric can equivalently regarded as lines of generalized Feynman diagrams are identified as orbits of 2-D partons performing kind of zitterbewebung with local light-velocity. The average velocity is typically time-like.

4. Massless extremals (MEs) are radiation type solutions but with local directions of polarization and light-like local propagation 4-velocity $(1, v(x)$ with $1 - v \cdot v = 0$. Since the direction can vary the average current is typically time-like.

   The first special feature is that MEs allow light-like currents parallel to $(1, v(x))$. Second special feature is that linear superposition is restricted to four-momenta proportional to the local four-velocity $(1, v(x))$ so that one can say that all Fourier components correspond to parallel four vectors $((1, v)$ and $(-1, -v)$ are regarded as parallel). Field pulses propagate in single direction without change in shape and in precisely targeted manner, which is optimal situation concerning information transfer.

   The general linear superposition of Maxwell's theory is lost and one can say that for given space-time sheet the field decomposes to quanta in geometric sense. Linear superposition is however replaced with set theoretic union of parallel space-time sheets: the test particle experiences the sum of gauge potentials associated with different sheets so that nothing is lost in Maxwellian limit.

Consider now what the TGD description could look like for standing waves.

1. Only linearly polarized waves with local wave vector k are possible. Circular polarizations are not representable classically. In many-sheeted space-time the problem can be solved by using two parallel space-time sheets with of orthogonal linear polarizations and suitable phase lag.

2. In circuit systems there are oscillating electric fields associated with the capacitor and also oscillating magnetic fields and electric fields accompanying them. These fields do not propagate although one can assign to them frequency and wave vectors locally. In Maxwellian theory they can be represented as superposition of real waves propagating in opposite directions with light-velocity $(cos(\omega t - kx) + cos(\omega t + kx) = 2cos(\omega t)cos(kx)$, $\omega = k$ using unit $c = 1)$.

   In TGD framework standing wave solutions are not possible as radiative solutions since only the waves with parallel local 4-velocities can superpose. At least two parallel space-time sheets representing copies of MEs related by 4-D reflection are needed to describe the fields in the region outside capacitor. Since the electric field is radial at the surface of capacitor C_2, the MEs should propagate parallel to C_2 near its surface.

Maxwell's theory involves currents in an essential manner although their description involves structural equations and is therefore only phenomenological. These fields have 4-currents as sources. In the recent case the currents are associated with the surfaces of inductances and more or less stationary charge densities with the surfaces of the capacitors.

1. In TGD framework the 4-currents correspond at quantum level to fundamental fermions at string world sheets and together with partonic 2-surfaces string world sheets carry the data needed by the strong form of holography (SH). This microscopic description is quite too far from the practical modelling of Tesla coils. SH guarantees 4-D description and the question concerns the translation of 2-D vocabulary to 4-D one. One question is what the fermionic currents assignable to the ends of fermionic strings correspond in 4-D vocabulary.

2. The field equations for Kähler action do not contain external currents explicitly. MEs however allow light-like currents parallel to them and by using parallel MEs with light-like currents boosted in opposite directions it is possible to obtain time-like net currents at Maxwellian limit.

   In particular, one can have stationary charge densities needed at the surfaces of C_2 as well as currents moving with non-relativistic velocities needed at the surfaces of the induction coils. The rule could be that parallel MEs gives rise to net current parallel to microscopic fermionic currents propagating along partonic surfaces: these currents can look stationary in induced metric at partonic 2-surfaces so that it need not expand).

3. String world sheets have their ends carrying fermion number at the 3-D light-like orbits of partonic 2-surfaces. Since monopole fluxes connect wormhole throats, the strings are parallel to monopole flux tubes connect fermions moving along light-like curves of space-time surface. If indeed so, magnetic flux tubes and ME form locally orthogonal network. One cannot therefore neglect the magnetic flux tubes (carrying dark matter). In the recent case this would suggest the presence of dark magnetic flux tubes in directions orthogonal to the capacitor C_2. These flux tubes would carry monopole flux and no current would be needed to generate this magnetic field: the cross section would be two sheeted closed surface rather than disk with boundary.

   The monopole magnetic flux tubes carrying dark matter emanating radially from capacitor C_2 would be essential for new physics effects. In particular, dark supra currents could flow along these flux tubes. Together with MEs they are proposed to play fundamental role in TGD inspired quantum biology.

To sum up, the TGD inspired model of Teslaphoresis could be seen as an application of basic ideas of TGD inspired quantum biology explaining macroscopic quantum coherence and dark matter. If so, Tesla would have observed dark matter and new quantum theory based on the hierarchy of Planck constants already century ago.

3.1 Could Carbon nanotubes (CNTs) and Tesla coils make possible living computers?

9 years after writing the above text, we had with Tuomas Sorakivi a Google assisted discussion about Carbon nanotubes (CNTs) (see this). Google's language model demonstrated convincingly

its power as a tool allowing us to get the information needed to test new ideas. Of course, the language models make mistakes so that they cannot be used as authorities. The discussion led to the idea that CNTs could give rise to conscious computers along lines discussed in [**?**]. A week later I realized that the phenomenon of Teslaphoresis discussed above 9 years earlier is highly encouraging in this respect.

3.1.1 Carbon nanotubes (CNTs) from the TGD point of view

CNTs are hexagonal lattices with a helical structure stable at room temperature. The hexagons form a helix and the pitch angle of the helix characterizes the helical structure. The notion of chirality makes sense and there is an analogy with DNA.

First some background.

1. TGD allows us to consider the possibility of hybrids of classical computers and quantum computers transforming them to genuinely intelligent living and conscious entities [**?**, **?**]. In the proposed model, the states of a topological qubit are realized as two states defined by the -OH side group and -O^- + dark protons (large h_{eff} on a magnetic body of the system.

   This dynamical topological qubit would accompany the ordinary bit. There are also more general identifications of topological qubits and cold plasmas are excellent candidates for the realization of dark qubits [**?**]. Dark protons could be replaced with dark metal ions and the findings of Blackman indeed support that dark Ca^{2+} ions are possible and led to the hypothesis about large h_{eff} hierarchy as phases of the ordinary matter behaving like dark matter.

2. The basic prediction of TGD is that the dynamics of the space-time surfaces as analogs of Bohr orbits for particles identified as 3-surfaces ise slightly-non-deterministic: this leads to what I call zero energy ontology (ZEO) [K6]. This is true also for the topological qubits: so that the temporal bit sequences defined by them are non-deterministic without a violation of the classical field equations. Temporal bit sequences are represented as Bohr orbit-like space-time surfaces and bits would correspond to the 3-D loci of non-determinism. The superpositions of these Bohr orbits as analogs of computer programs are possible and would accompany the classical program. Similar situation would prevail at the level of DNA and RNA [**?**, **?**].

Could the -OH side groups be added to a CNT somehow to build a topological quantum computer and could CNT also give rise to a counterpart of ordinary bit as a transistor? This would give rise to a conscious computer [**?**]. Here Google Gemini came to the rescue.

1. In the CNT lattice, 3 valence bonds emanate from each C. The remaining electron is delocalized to a hexagon forming an aromatic ring. sp^2 hybridization, where s and p characterize electron orbitals, occurs. The energy spectrum of the π electron is in the range 1 meV - few eV.

2. The problem is that there are only C atoms present in CNT: -OH side groups must be created. Google informed us that this is possible. If the π electron is localized, the -OH can be placed at the resulting defect.

3. This cannot yet give a hybrid of quantum - and classical computers. How to get ordinary bits as partners for these topological qubits? A transistor provides the standard realization of a classical bit. Are CNT transistors possible? And again Google helped us: CNT transistors (CNFETs) represent a possible future technology and they define a basic research area in electronics!

3.1.2 CNTs and Tesla coils

The unexpected self-organization of the CNTs in the electromagnetic field of the Tesla coil [D1] (see `http://tinyurl.com/htyaf4h`), occurring in unexpectedly long length scales of order 30 cm and involving their alignment, brings to mind microtubules.

1. For a believer in standard physics Tesla coils (see this) are a mere entertainment tool. From the TGD point of view they might be much more, a primitive life form. Google Gemini informs that Tesla coil is a resonant transformer circuit producing extremely high-voltage, high-frequency alternating current that creates spectacular lightning-like electrical arcs and demonstrates wireless energy transfer and high-frequency phenomena like X-rays and phosphorescence. It works by using coupled coils, capacitors, and spark gaps to amplify voltage dramatically, often exceeding a million volts, which corresponds to the mass scale of the electron.

   The electricity generated by the Tesla coil travels over the skin without harm, and lights up bulbs wirelessly. Standard physics explains this in terms of high frequency. In the TGD framework, the frequency would be very low but the energy $E = h_{em}f$ would be high and could cause the exotic looking remote effects by energy resonance with ordinary matter with standard value of h_{eff}.

2. Tesla coils carry both classical magnetic fields and electric fields. The self-organization suggests a long range quantum coherence in length scales of order 30 cm.In the TGD framework one can speak of the electric body of the system characterized by a large value of electric Planck constant h_{em} and plasma phase [?]. Therefore the Tesla coil could be an essential element in making the system a macroscopically quantum coherent system.

3. In the TGD framework, this suggests that a large value of $h_{eff} = h_{em}$ proportional to the electric field strength [?] characterizes the electrons and makes possible for electrons to have long wavelength. Also dark protons at the magnetic body of the system would be present and could be characterized by the gravitational Planck constant $\hbar_{gr}$ of the Earth. Pollack effect would transform protons to dark protons and generate a negative charge. This would make Tesla coils analogous to charged biological systems like DNA, microtubules and cells carrying strong electric fields.

   In the absence of a metabolic energy feed, the values of h_{eff} for particles tend to decrease. The electric fields require a charge separation and permanent negative charge is a direct signature for the presence of condensate of dark protons at the magnetic body. Metabolic energy feed is required but would be used to preserve the electric field rather than to kick the protons back to the magnetic body. This mechanism would make DNA and RNA with constant linear charge density completely unique information molecules [?]. Something analogous would happen in the case of Tesla coil at its field bodies.

3.1.3   A more detailed view of Tesla coils

It is interesting to look at the Tesla coil in more detail. Tesla coil consists of primary coil and secondary coil with a resonance coupling between them.

1. The primary circuit is coupled to AC current source via a coil L_{AC} (this is not the primary coil L_1), which feeds energy to the circuit with a period τ_+. The AC frequency $\omega_{AC} = 2\pi/\tau_{AC}$ is rather low, typically 50 Hz.

   The AC current generates an oscillating magnetic field in L_{AC} and charge is transferred to the capacitor C_1 of the primary. The primary circuit has a gap making the flow of current impossible and it remains an open circuit oscillating with period ω_{AC} . The situation changes if the voltage in the capacitor C_1 exceeds the critical value and causes dielectric breakdown so that current starts to flow through the gap. The criticality must be achieved in time $\tau_1 < \tau_{AC}/2$. After that the primary circuit becomes a resonant circuit characterized by the frequency $\omega = 1/\sqrt{L_1 C_1}$ which is in radio frequency range and AC current continues to feed charge to C_1 until half period is achieved.

2. The primary circuit has a resonance coupling to a secondary circuit by mutual inductance L_{12}. The secondary circuit is characterized by inductance L_2 and capacitance C_2 and the resonance condition $\omega_2 = 1/\sqrt{L_2 C_2} = \omega_1$ is satisfied. C_2 can involve a physical capacitance, typically a conducting sphere and also stray capacitance.

   There is a periodic transfer of charge between C_1 and C_2 and the AC current feeds in charge. The current oscillates in the circuit resonant circuit but the charge of C_1 oscillates around

some value. Is this value the critical value? Why doesn't this lead to an immediate opening of the primary circuit?

Is the oscillation amplitude of the charge oscillation so small that this does not happen? The fact that there are dielectric breakdowns in both C_1 and C_2 means that rather large charge transfers are involved. Is the oscillation frequency ω_1 so fast that the current flowing through the gap does not have time to react? In this case the oscillation could last for several periods τ_{AC}.

3. What is the role of the AC current? For $\tau_1 < t < \tau_{AC}/$ there is a charge transfer to C_1 but this is very slow in the time scale of the resonance circuit. After $t = \tau_{AC}/2$ the AC current tends to reduce the charge of C_1. Does this lead to the opening of the primary circuit? If this is the case the system is periodic with frequency ω_{AC}.

4. There are several time scales involved: the time $\tau_1 < \tau_{AC}/2$ after which dielectric breakdown occurs, the common time scale $T = 2\pi/\omega_1$ of the resonance circuits and the duration of the resonant oscillation period, which in the simplest situation would correspond to $\tau_{AC}/2 - \tau_1$. The simplest picture is that each cycle of AC current gives rise to the resonant oscillation period. The duration of the resonant oscillation indeed varies from a few hundred microseconds to milliseconds, which happens to be the time scale of nerve pulse.

5. Very high voltage and charges develop in the secondary circuit. Radio waves with the resonance frequency ω_1 are generated. Energy is transferred wirelessly: for example, a distant light bulb lights up. Tesla's dream was indeed wireless energy transfer: his colleagues took this demonstration as mere entertainment, imagining that Maxwell's theory was the final description of electricity. It is shocking how far ahead of his time Tesla was.

3.1.4 How Tesla coils could make possible a living CNT computer

The consideration of the Tesla coil from the perspective of TGD could stimulate some ideas about how one might build living computer like systems using Tesla coils and CNTs.

1. The large charges in the capacitors C_1 and C_2 generate so strong electric fields that dielectric breakdown occurs in both of them. In the TGD framework [**?**], the strong electric field is accompanied by dark electrons with a very large value $h_{eff} = h_{em}$ proportional to the electric at the surface of the capacitor. Also dark protons at the magnetic body of the Earth could be generated. The long range of quantum coherence could explain the strange effects observed in length scales much longer than the size scale of the system and also the energy transfer by radiation over long distances.

2. Could the capacitor pair act as Josephson junction and generate oscillating non-dissipative Josephson currents generating Josephson radiation? This would mean an analogy with the cell membrane as it is modelled in TGD [**?**].

   In the TGD based model of EEG, the Josepson radiation mediates information to the magnetic body of the system and cyclotron frequencies for dark ions in the "endogenous" magnetic field $B_{end} \simeq 2B_E/5$, where $B_E = .5 Gauss$, assignable to monopole flux tube loops mediating the Earth's gravitational field, are favoured. These frequencies are in EEG range and correspond to resonance frequencies. The AC frequency, which for Tesla coils is typically 50 Hz, corresponds to the cyclotron frequency of a Lithium ion.

   One can ask whether the di-electric breakdowns could be analogs of nerve pulses. Note however that the nerve pulse is generated when the membrane potential is below a threshold rather than above it.

3. Radio waves with frequencies typically between 40 kHz and MHz are generated and energy and information are transferred wirelessly. An interesting possibility is that the photons with AC frequency are dark and have the same energy as the photons of ordinary radio wave photons. This requires $h_{em} = \omega_1/\omega_{AC}$. Already the wavelength λ_{AC} is rather long: for $f = 1$ MHz the wavelength would be $\lambda_1 = 300$ m. The presence of the gravitational magnetic body

of the Earth suggests the presence of dark photons with energies which can be even in the visible range.

The scaled up wavelength for $f_{AC} = 50$ Hz would be $\lambda_{AC} = 6000$ km to be compared with the Earth's radius $R_E = 6,371$ km. Dark photons with wavelength of order Earth radius energy of radio wave photons might realize the dream of Tesla about effective energy transfer in the size scale of the Earth. The energy of these photons would be about 10^{-8} eV and rather small. For dark photons producing biophotons the energy would be in visible and UV range.

4. The lighting of the bulbs is believed to be caused by strong electric fields associated with the Tesla coil. In fluorescent bulbs (ionization), the strong radio frequency electric fields generated by the Tesla coil accelerate electrons which collide with gas atoms and ionize them and create a plasma. The photons from the decays of excited electrons generate light. In the case of incandescent bulbs (induced current), the changing electric and magnetic induce currents directly to the bulb's tungsten filament.

   Could the large value of h_{eff} possibly associated with the "massless" extremals [K5] associated with the radiation could make possible dissipationless acceleration scaled up length scale, increasing the energies achieved in the acceleration. Also in the case of electrolytes the problem of how the relatively weak electric fields can induce ionization is encountered and the TGD proposal for the mechanism is the same as in the recent case.

5. In the TGD inspired biology, dark EEG photons transfer information. Could the Tesla coils plus CNTs give some day raise to conscious computers forming networks using dark AC photons to communicate. Could the biosphere do this already?

3.1.5 Tesla globes from the TGD view point

The following considerations were inspired by a Zoom discussion with Ville-Einari Saari and Marko Manninen about Tesla coils, in particular plasma lamp, also known as plasma globe, invented by Tesla (see this).

In TGD, both magnetic and electric fields are replaced by flux tubes which can also be monopole flux tubes. Electric flux tubes are deformations of magnetic ones. Magnetic and electric fluxes flow along them. This picture leads to a rather dramatic modification of the models of the atom and nucleus developed a couple of years ago. In the model also the Platonic solids also appear [?] (see this). I am still a bit incredulous: can such a big revolution be possible at these supposedly well-known scales.

Monopole flux tubes are not visible except in the case of permanent magnets, when the magnetized substance accumulates around the flux tubes. Flux tubes are very thin and are not visible on the atomic and nuclear scales. How to make flux tubes visible in the general case? To be visible they should radiate and this requires charges.

1. The situation changes if the effective Planck constant h_{eff} is large. A good guess is that the flux tube thickness corresponds to the Compton wavelength, which scales with h_{eff}. The electric and gravitational Planck constant $\hbar_{em} = Qq/\beta_0$ and h_{gr} are natural candidates.

2. Consider first the gravitational option.

   Gravitational flux tubes are special in that each particle connected to a gravitating large mass M, say Earth, is characterized by gravitational Planck constant $\hbar_{gr} = GMm/\beta_0 = r_S m/2\beta_0$, $\beta_0 = v_0/c \leq 1$, proportional to the particle mass m and M. Each particle is on its own flux tube. This assumption makes sense only for $\hbar_{gr}/\hbar > 1$.

   The Equivalence Principle implies that the gravitational Compton wavelength $\Lambda_{gr} = GM/\beta_0$ does not depend at all on the mass of the particle so that the thickness of the flux tube would be the same regardless of the particle mass. For the Earth with $\beta_0 = 1$ it is one half of its Schwartzchild radius, which is about .1 cm. This is also the size scale of a snowflake. This is the order of these flux tube thicknesses inside the plasma sphere having a Tesla coil in itse interior! A testable prediction of this model that the flux tube thickness does not depend on the parameters of the Tesla coil.

3. For $\hbar_{em} = Qq/\beta_0$, where $Q = \int E dS$ is electric charge assignable to a classical electric field of an object, which could be charged ball in Tesla coil or the capacitor C_1 in the primary of the Tesla coil. The thickness of the flux tube identified as electric Compton length would be given by $_{em} = Qq/\beta_0 m$. For electrons, the thickness would be about $m_p/m_e \sim 1000$ times larger than for protons.

   One obtains an order of magnitude estimate by using $\beta_0 \simeq 1$, $q = e$. The electric field eE causing a dielectric breakdown in air is $3MeV/m = 3m_e/m$. This value of electric field gives for $\beta_0 = 1$ $\Lambda_{em} = S/m$. According to the Google language model, the estimate for the effective area of the plate of the primary capacitor C_1 in the Tesla coil varies from .75 m^2 to 2 m^2. For the electron, this gives $\Lambda_{em} = (S/m^2)$ meters so that the flux tubes would be rather thick. For the proton, the formula gives $\Lambda_{em} \sim .53 \times (S/m^2)$ mm so that one would have $\Lambda_{em} \sim 5\Lambda_{gr}$. Could one consider some kind of electric-gravitational resonance?

4. h_{eff} tends to spontaneously decrease for the charges located at the flux tube by a transformation to ordinary charge. The dark energy is released as ordinary photons. This could make the flux tube visible if the emitted light is in the wavelength range of visible light. It could be possible to see the electric flux tubes with the naked eye! The might-be flux tubes inside the plasma ball tesla coil (also known as lava lamp) fluctuate continually. This could correspond to quantum criticality, which is due to the charge of the primary capacitor being close to the critical charge causing the dielectric breakdown through the gap. In the TGD Universe, quantum criticality is a fundamental feature of living systems

   For a given frequency f, the energies $E = h_{em}f$ are the same for the electron and proton. The cyclotron frequencies are proportional to $1/m$. For $\hbar gr$ the cyclotron energies do not depend on particle mass and are therefore the same for electrons and protons. For h_{em} the cyclotron energies for electron and proton relate by a factor m_p/m_e. For h_{em} the flux tube thickness scales like m_p/m_e so that the magnetic field strengths would scale like $1/S \propto (m_e/m_p)^2$ by flux quantization and the dark cyclotron energy would scale like m_e/m_p. If protons produce visible radiation in the eV range , electrons would produce radiation in the meV range. One could test whether meV radiation is present.

5. In the example about Tesla globe (see this). considered in the Zoom discussion, the disturbance of the supply current using a magnet led to the disappearance of the flux tubes. This could be due to that, due to the disturbance, energy was no longer fed into the system as efficiently, so new electrons and/or protons with a large h_{eff} were no longer created and the system "starved". The charges disappeared from the gravity tubes and the flux tubes were no longer visible. The thickness of the flux tubes supports that protons were involved and were located eith on the electric or gravitational flux tubes.

6. Tesla globes create electric arcs, which can be controlled by touch and music. The fascinating self-organization patterns induced by music challenge the belief that standard physics can explain their behavior.

3.2 How large h_{eff} states are stabilized?

The quantum critical state is unstable by definition because the $h_{eff} \geq h$ states are more energetic than the $h_{eff} = h$ states and spontaneously decay into these. One way to avoid this would be for the $h_{eff} \geq h$ molecule to form a bound state, for example with a molecule or a larger structure. The electric field of the larger charged structure and that in turn a state where h_{eff} would be stabilized. However, I do not understand the details of the mechanism. How to build a state in which $h_{eff} \geq h$ dark protons are possible in the minimum energy state. Is this possible if only the electromagnetic interaction is involved?

This is a fundamental question. So let's start from a clean table.

1. In the case of DNA and cell membranes, h_{eff} stabilization is related to the presence of electric fields, but do they produce the stabilization or are they a consequence of it?

   A $h_{eff} \geq h$ state and a state bound with another state are created so that the $h_{eff} \geq h$ state stabilizes because the dissociation is no longer energetically favorable. It should be

noted that due to their large negative charge DNA and the cell membrane are biologically completely unique. Charge separation does also occur at the level of the brain and the whole body and its sign correlates with the level of consciousness: the sign of the voltage changes during sleep. The Earth itself also has an electric field, which suggests that the biosphere is conscious.

2. In the case of DNA, the bound state would be between phosphate and deoxyribose. Would the large $h_{eff} = h_{em}$ somehow be made possible by the longitudinal and radial electric fields of DNA or is it a consequence of a stabilization mechanism? Maintaining the electric field requires energy, so metabolic energy input is still necessary but at the level of classical fields. But do electric fields maintain dark protons at the monopole flux tubes or vice versa?

   The problem: In the case of DNA, the repulsive energy of the negative charges of the phosphates destabilizes the state. In addition, there is repulsion between the dark protons in the flux tubes. Charge separation, where the dark protons and the phosphate ions are far apart, requires energy because the neutral ground state is of minimum energy.

   The solution of the problem: Some interaction energy must compensate for the increase of the interaction energy. Could strong interactions of the dark protons in the flux tubes, proposed to form dark nuclei with a scale down nuclear binding energy, be involved? The strong interaction would stabilize the repulsive energy of the negative charge of the phosphates, the same would happen for the dark protons. Long range electric field would be a consequence, not the cause.

   (a) The TGD-based model of cold fusion [**?**, **?**, **?**, **?**] indeed assumes that the dark protons in the magnetic flux tubes form an analogy of the atomic nucleus and the scaled binding energy of the nucleus would produce the binding energy. Strong interactions in the TGD sense would play a key role in biology and also in electrolysis. This would be new and revolutionary.

   (b) Of course, one could try to cope with just electromagnetic interactions.

      i) The negative electrostatic energy would be between the dark protons and the negative charge of the phosphates. One would expect this energy to be small, but is it for flux tubes?

      ii) What about the role of water? It can become positively charged (and for example Mg^{2+} ions do), which can produce a Coulomb bound state. Mg^{2+} ions are naturally present in monopole flux tubes, but is the contribution large enough?

      iii) The binding energy is related to the bound state between negatively charged phosphates and riboses. The problem is that ribose molecules are not permanently positively charged. This doesn't seem promising.

   (c) In the case of the cell membrane, the electric field associated with the membrane potential should accompany large values of h_{eff}. A decrease in the field strength below a critical value would lead to a decrease in the value of h_{em}, perhaps down to $h_{eff} = h$ because h_{em} is proportional to the field value and quantized as an integer. The scale of quantum coherence would be reduced and a nerve impulse would be generated.

      The naive Maxwellian assumption would be that a nerve impulse is generated when the voltage is too high: there would be a di-electric breakdown, just as is supposed to happen in a Tesla coil. The fact that exactly the opposite happens is a central mystery of biology. A decrease in h_{em} would explain the mystery. One can pose an interesting and somewhat nosy question: has it really been tested that breakdown is the correct mechanism in Tesla coils?

      Also now the strong interactions with monopole flux tubes would stabilize the state.

   (d) The negative charge on the surface of the Earth's electric field and the protons and ions in the gravitational flux tubes and electric flux tubes and their strong interaction would stabilize the biosphere as a conscious system.

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