Did Tesla Discover the Mechanism Changing the Arrow of Time?

M. Pitkänen,

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Email: matpitka6@gmail.com.
http://tgdtheory.com/public_html/.
Postal address: Rinnekatu 2-4 A 8, 03620, Karkkila, Finland. ORCID: 0000-0002-8051-4364.

Contents

Abstract

Negative energy topological light (phase conjugate laser waves) rays provide the fundamental control mechanism in the TGD based model of living matter and appears in practically every mechanism of consciousness as a basic step. Zero energy ontology provides the theoretical justification for the notion of negative energy particles. This is however not yet the whole story. One should also identify mechanisms allowing to control the generation of the negative energy topological light rays: direct transformation of p-adic MEs to negative energy MEs is probably not enough.

A possible solution of the problem came from an quite unexpected direction. It was the attempt to understand the physics behind the visions of Tesla which led to an identification of a very general mechanism of this kind. I had already earlier proposed that Tesla's scalar wave pulses might be described in terms of solutions of field equations in TGD framework but the physical interpretation had remained obscure.

In this chapter the general vision possibly allowing to understand the findings of Tesla and others relating to binary coils and Tesla transformers are discussed. The basic idea is that the rapid acceleration of charges induced by scalar wave pulses induces generation of negative energy topological light rays as time reversed counterpart of brehmstrahlung. Candidates for the solutions of field equations describing Tesla's scalar wave pulses are discussed first. Various strange findings of Tesla are discussed at a general level using the resulting over all picture. The solution ansatz is however approximate and need not be a preferred extremal of Kähler action. Another model for the scalar waves is as massive photon like states which correspond to MEs with opposite 3-momenta and same helicity and therefore non-vanishing rest energy and vanishing spin. The Lorentz boosts of this solution give scalar photons.

The chapter ends with the model for the causal anomalies observed in the tunnelling of photons through potential barriers.

1 Introduction

After having made the inventions providing much of the basis technology for the modern electricity based society, Tesla used the rest of his life to study the strange phenomena related to sharp electric pulses. Tesla became convinced that pulse like rays carrying longitudinal electric fields exists although Maxwell's theory does not allow them. Needless to say, Tesla's findings were not taken seriously by the scientific establishment. On the other hand, for the developers of so called free energy technologies Tesla has remained a magic figure. To me it has gradually become clear that it might be possible to formulate the visions of Tesla using the language of modern physics.

The final breakthrough came with a discovery of a mechanism generating what I have used to call negative energy topological light rays having phase conjugate laser waves as physical counterparts. Negative energy topological light rays provide the fundamental control mechanism in the TGD based model of living matter and appear in practically every mechanism of consciousness as a basic step. This is however not yet the whole story. One should also identify mechanisms allowing to control the generation of the negative energy topological light rays: direct transformation of p-adic MEs to negative energy MEs is probably not enough. The solution to the problem came from a quite unexpected direction. It was the attempt to understand the physics behind the visions of Tesla which led to an identification of a very general mechanism of this kind.

Phase conjugate laser waves break second law of thermodynamics and this is possible in TGD Universe below the p-adic time scale characterizing the system. Therefore short pulses are ideal for this purpose. Depending on the situation, electric pulses in electric circuits typically force the charge carriers to accelerate or decelerate. During deceleration positive energy photons are emitted as brehmstrahlung whereas during acceleration charges emit negative energy photons in order to receive energy. Thus generation of pulses provides a mechanism to generate negative energy topological rays which in turn serve for various control purposes. TGD indeed predicts the existence of scalar wave pulses propagating in vacuum with light velocity and carrying longitudinal electric fields.

One can understand the basic findings of Tesla at qualitative level in TGD framework and there are strong reasons to believe that Tesla was right after all. This of course raises the question how it is possible that the scientific community with all its technology remained silent about the findings of Tesla for an entire century. Experimentalists must have made occasional encounters with the

phenomena reported by Tesla. Are modern experimentalists conditioned to take theorists quite too seriously?

In this chapter the general vision allowing to understand the findings of Tesla and others relating to binary coils and Tesla transformers are discussed. The solutions describing Tesla's scalar wave pulses are discussed. The new physics associated with binary coils is discussed in detail and a detailed model for binary coil and transformer using binary coil as a primary is constructed using the experimental input provided generously by Tapio Tammi. The findings of Tesla are discussed at general level using the resulting over all picture. The chapter ends with the model for the causal anomalies observed in the tunnelling of photons through potential barriers.

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

2 Discussion Of The Basic Ideas And Concepts

2.1 Do Negative Energy Space-Time Sheets Have Counterparts In Quantum Field Theory?

Negative energy topological light rays seem to correspond to phase conjugate laser waves. In particular, the experiments of Feinberg [D1] are consistent with the transparency of matter for phase conjugate laser beams with photon energies above thermal energy. In optics phase conjugation requires optically non-linear system [D4]. For instance, in usual hologram the matter is optically non-linear in the sense that dielectric constant depends on the external electric field so that the electromagnetic radiation induces a change of the refraction coefficient which in turn codes for the hologram.

The dynamics of classical fields is indeed extremely nonlinear in TGD: the topological field quantization is one of the most dramatic outcomes of this non-linearity. Whether the phenomenological models for phase conjugate waves and for their generation are enough in TGD framework is an open question. The mechanism based for the generation of negative energy topological light rays based on short pulses to be discussed in this section does not seem to reduce to the framework of non-nonlinear optics.

There are also questions of principle involved.

2.1.1 Is phase conjugation properly understood in quantum field theories?

At the level of quantum physics negative energy photons would correspond to a system quantized in such a way that both bosonic and fermionic annihilation and creation operators have changed their roles. Negative energy photons and fermions do not correspond to (non-existing) "anti-photons" and anti-fermions. Using the terminology of Dirac's bra-ket formalism: negative energy systems are like bras if positive energy photons are kets. Kets and bras correspond to Hilbert space and linear functionals defined in it. The space of bras is actually not equivalent with that of kets but in a well defined sense a more general concept. This conforms with the role of negative energy space-time sheets in TGD inspired theory of consciousness.

In quantum field theories time reversal transforms creation operators for fermions to creation operators for anti-fermions. Vacuum state is not changed. Time reversal in TGD sense would transform ket vacuum to bra vacuum so that the earlier creation operators annihilate the new vacuum state and genuine negative energy states result. This would suggest that negative energy states are something genuinely new and a genuine outcome of the many-sheeted space-time concept allowing either bra and ket type vacuum at a given space-time sheet. It has turned out that zero energy ontology (ZEO) allows to formulate this intuition rigorously.

2.1.2 Phase conjugation and irreversibility

One interesting aspect associated with negative energy topological light rays is that they seem to be irreversible systems. On the other hand, phase conjugation can be used to eliminate perturbations on signal caused by thermal noise since the evolution proceeds from perturbed to non-perturbed

signal. This could be seen as an objection against TGD based interpretation stating that topological light rays are essentially non-dissipative structures of classical physics.

The objection can be circumvented. Classical-quantum correspondence implies that space-time physics mimics also the dissipative aspects of quantum dynamics defined by quantum jump sequences. The classical non-determinism of the basic variational principle makes this possible. Classical fields are non-dissipative structures are even able to represent information about dissipation, analogous to a written text telling a story about growth, flourishing, and decay. In fact, in TGD framework space-time itself provides symbolic classical representations for quantum jump sequences determining the subjective, experienced reality. The implications of this representative aspect for biology are highly non-trivial. For instance, phase conjugate waves could provide a fundamental mechanism of healing and error correction.

2.1.3 Matter-antimatter asymmetry, phase conjugation for fermions, and new energy technology

If photons with negative energies are allowed, it is difficult to deny the possibility of fermions with negative energies. The possibility of having both signs of energy suggests an elegant solution to the problem of matter-antimatter asymmetry and a powerful new energy technology.

1. The standard second quantization of Dirac spinors postulates that ground state is annihilated by annihilation operators for fermions and anti-fermions. One can construct explicitly the state annihilated by annihilation operators. Suppose that there is state which is not annihilated by any annihilation operator and apply the product of all annihilation operators to this state. Electrons and positrons represent holes in this sea and are created by applying creation operators. The states have positive energy with respect to the ground state. The aesthetic problem of this quantization is that ground state has an infinitely high negative energy.

2. In TGD framework one could change the role of creation and annihilation operators so that the ground state would be obtained by applying the product of all creation operators to vacuum. This state would have infinite positive energy. Fermions and anti-fermions would be holes in Dirac sea of positive energy and behave as negative energy quanta. One might expect that these two quantizations correspond to two different time orientations for the space-time surface.

1. Two ways to circumvent the infinite vacuum energy

The infinite vacuum energy is definitely something very unsatisfactory, and one should overcome this problem somehow. The most elegant and predictive variant of TGD inspired cosmology assumes that the net energy of the Universe vanishes so that the universe could have been created intentionally from vacuum (and be created again and again in each quantum jump). The vanishing of the total energy follows automatically if one poses the condition that the energy flow through the light cone boundary ($H = M^4_+ \times CP_2$) vanishes. This requires that also fermionic vacuum energies cancel each other. There are two ways to achieve the cancellation.

1. If positive and negative energy space-time sheets are always created in a pairwise manner their vacuum energies could compensate each other, at least so if some additional conditions are satisfied. The success of elementary particle physics requires that this mechanism is at work in elementary particle length scales.

2. Vacuum energies could also cancel each other for each space-time sheet separately. This is achieved if the roles of creation and annihilation operators for either fermions or anti-fermions are exchanged. This implies automatically matter antimatter asymmetry since either fermions or anti-fermions would have negative energies. This option could be realized in long length scales and explain the absence of antimatter from the Universe as absence of positive energy antimatter. It would thus seem that all four ground states states are in principle possible and that the ground state characterizes the phase of matter.

2. Zero energy vacuum is matter-antimatter asymmetric

Consider now in more detail the latter option 2) assuming for definiteness that it is anti-fermions for which the roles of creation and annihilation operators are exchanged. The ground state is obtained by applying the product of all fermion annihilation operators and anti-fermion creation operators to vacuum. Fermions represent holes in a completely filled negative energy Dirac sea and have positive energy. Anti-fermions represent holes in positive energy Dirac sea and have thus negative energy. In this ground state annihilation of photon pair is possible only to an fermion with positive and anti-fermion with negative energy.

Obviously the state is matter-antimatter asymmetric since anti-fermions cannot appear as positive energy holes. Negative energy antimatter could be present but could have remained invisible. For instance, Pauli Exclusion Principle would make the scattering of negative energy anti-fermions impossible in the case that there are not sufficiently many holes in the sea. The same occurs for condensed matter electrons below the surface of the Fermi sphere. Even in the case that negative energy anti-fermions are present abundantly, they might have escaped detection. Due to the prevailing dogmas, no-one has tried to detect signatures for the scattering of negative energy anti-fermions or two photon annihilation to a pair of positive energy fermion and negative energy anti-fermion.

3. Creation of matter from vacuum by annihilation of laser waves and their phase conjugates?

The possibility of negative energy anti-fermions suggests a new energy technology. Photons and their phase conjugates with opposite energies could only annihilate to a pair of positive energy fermion and negative energy anti-fermion. Vacuum could effectively serve as an unlimited source of positive energy and make creation of matter from nothing literally possible. The idea could be tested by allowing laser beams and their phase conjugates to interact and by looking whether fermions pop out via two-photon annihilation. Fermion-anti-fermion pairs with arbitrarily large fermion masses could be generated by utilizing photons of arbitrarily low energy. The energies of the final state fermion is completely fixed from conservation laws so that it should be relatively easy to check whether the process really occurs. Generalized Feynman rules predict the cross section for the process and it should behave as $\sigma \propto \alpha^2/m^2$, where m is the mass of the fermion so that annihilation to electrons is the best candidate for study. Bio-systems might have already invented intentional generation of matter in this manner. Certainly the possible new energy technology should be applied with some caution in order to not to build a new quasar!

2.2 Is The TGD View About Phase Conjugate Waves Consistent With The Existing Wisdom?

A priori it is is not obvious that the TGD based identification of phase conjugate waves as negative energy photons/topological light rays is consistent with what is known about phase conjugate waves. The best manner to check this is to translate the standard physics description of the basic mechanisms producing phase conjugate waves to the language of TGD. This should also provide new insights about how self-organization by the emission of negative energy photons proceeds in non-linear media.

2.2.1 Basic mechanism producing phase conjugate waves

There are two basic mechanisms producing phase conjugate waves. The physics believed to be behind these mechanisms is summarized in an enjoyable manner in the book of D. M. Pepper [D4], and in the review article of V. V. Shunov and B. Ya. Zeldovich [D8], who are pioneers of optical phase conjugation. The mechanisms rely on four-wave mixing and stimulated Brillouin scattering. Both mechanisms can be modeled using the notion of a dynamical hologram. In TGD framework dynamical hologram can be regarded as a spontaneously generated self-organizing hologram resulting by the emission of negative energy photons. The reference laser beam is quite generally pulsed. This raises the question whether the phase conjugate photons are produced by negative energy scalar wave pulses inducing negative energy "acceleration radiation" as the (em- or Z^0-) charged particles are accelerated at the space-time sheets representing scalar wave pulses.

The recent view (2019) is that scalar waves are not possible as single-sheeted structures in TGD framework. Many-sheeted space-time could however allow effective scalar waves as two-sheeted structures realized as a pair of massless extremals (MEs) representing waves of opposite polarization propagating in the same direction. From the point of view of test particles the effect of MEs is indeed like that of a scalar wave. This variant of scalar wave could explain the findings claimed by Tesla.

The following considerations were written much earlier and consider genuine scalar waves as a single-sheeted structures as a possible option. I do not believe in this option anymore.

1. Four-wave mixing

Consider first four-wave mixing. The basic observation is that already in the case of ordinary hologram a phase conjugate beam is generated when the reference beam irradiating the hologram has a direction opposite to that of the original reference beam. The idea is to replace the static hologram with a dynamic hologram by utilizing reference beams moving in opposite directions simultaneously besides the probe beam coming from the object, so that the beams used to construct and read the hologram are simultaneously present. Either reference beam can be thought of as being scattered from the interference pattern created by the other beams and producing the phase conjugate wave. The resulting phase conjugate wave moves in a direction opposite to the probe beam, just as in the case of the ordinary hologram. The dynamic hologram is created in the non-linear medium whose properties are affected by the interference pattern formed by the beams.

TGD description would be that the interference of the three beams induces self-organization of the non-linear medium to a higher energy state representing the dynamic hologram and that this occurs by the emission of the phase conjugate wave having negative energy. This means the breaking of the second law of thermodynamics. The phase conjugate waves are dissipative structures but the dissipation takes place in a reversed direction of geometric time. To be precise, classical fields can be seen as symbolic representations for the dissipation at quantum level and possible by the non-determinism of Kähler action. This explains the strange features of phase conjugate waves.

Remark: In the light of the after wisdom emerged during two decades, one could describe the four-wave mixing in the framework of zero energy ontology (ZEO). The generation of phase conjugate wave from a state of 3 ordinary waves could be seen as a "big" (or "ordinary") state function reduction (SFR) in which the arrow of time of state changes - phase conjugate waves indeed propagate backwards in time. No change of the arrow of time takes place in "small" SFRs, which correspond to so called weak measurements [**?**].

2. Stimulated Brillouin scattering

Stimulated Brillouin scattering was first discovered to produce phase conjugate waves [D8] by Boris Ya. Zeldowich and his colleagues, the Russian pioneers of optical phase conjugation. Only single incoming reference beam is used and the secondary reference beam in the opposite direction appears spontaneously. In this case three-wave scattering without probe beam is in question and interference pattern is solely due to the interference of the reference beams. The dynamical hologram is realized as an acoustic wave pattern from which either reference beam can be said to scatter. The phase conjugate wave is generated only above a critical power feed for the incoming beam. The incoming beam can be distorted in the directions transversal to the primary beam by allowing it to traverse an inhomogeneous glass plate. The resulting phase conjugate beam traverses back through the inhomogeneous glass plate and turns out to be free of any distortions. Obviously this demonstrates the occurrence of the time reversal.

The standard description for what happens runs as follows.

1. The process is initiated by the scattering of photons from thermal phonons in the direction of the primary reference beam and reversing thus their direction. By energy conservation the frequency difference for the two light beams corresponds to the frequency of the acoustic wave: $\Delta\omega/\omega = v/c$, where v is the sound velocity.

2. Acoustic wave generates a periodic longitudinal density gradient such that the zones of low and high density are at a distance of *half* wave length: this follows from the fact that the scattered phonons receive *twice* the momentum of photon. In this kind of situation total

reflection occurs from each layer and this amplifies the secondary light beam which in turn amplifies the sound wave. A more familiar example of total reflection is the reflection of light on water having oil layer at its surface. The varying thickness of this layer gives rise to a rainbow like appearance of the scattered light. Also a phase conjugate beam is created in the process.

In TGD framework situation can be seen as a self-organization process in which the self-organizing acoustic wave gains energy by emitting negative energy photons: obviously an over unity energy production breaking the second law of thermodynamics is in question. One could even say that non-linear medium builds a primitive sensory representation of the interference pattern.

1. At the first step the photons of the primary reference beam are scattered and generate a weak secondary reference beam in an opposite direction. The resulting interference pattern in turn excites a weak acoustic wave.

2. The acoustic wave amplifies itself when phonons emit pairs of positive and negative energy photons with energies $E_1 > 0$ and $E_2 < 0$ such that the sum of their energies corresponds to the energy E_{ph} gained by the phonon: $E_1 - |E_2| = E_{ph}$. The rate of this process is proportional to the numbers N_+ and N_- of positive and negative energy photons already present in the state: the mechanism of induced emission is at work. Positive energy photons amplify the induced reference beam and negative energy photons amplify the phase conjugate wave. Also in this case one can say that the non-linear medium builds up spontaneously a dynamical hologram about the interference pattern.

Remark: Also Brillouin scattering allows a description in terms of ZEO. In the previous situation one had incoming photon beam and two reference beams producing phase conjugate beam. Now the incoming photon beam is replaced with incoming acoustic wave and one has single reference beam and phase conjugate of reference beam is produced.

2.2.2 Over unity effects and error correction

The emission of negative energy photons makes possible over unity effects claimed by free energy enthusiasts. Over unity effects need not be in conflict with the standard wisdom that phase conjugate waves utilize the energy of pumping laser or probe beam. In the case of stimulated Brillouin scattering the negative energy photons are received by the population inverted lasers producing the reference beam with the consequence that particles drop to the ground state without emission of positive energy photons. In the case of 4-wave mixing the negative energy photons could be received by the laser producing the probe beam. An interesting possibility is that negative energy beams could be produced also in the direction of reference beam and pump energy from the corresponding lasers.

Error correction of a signal defines a variant of the time mirror mechanism (see **Fig.** `http://tgdtheory.fi/appfigures/timemirror.jpg` or **Fig. ??** in the appendix of this book). In this case positive and negative energy signals are actually at different sides of the time mirror. The positive energy photons photons of the signal to be corrected annihilate with the negative energy photons of the phase conjugate signal which comes from the geometric future and is a temporal mirror image of the positive energy signal. The pulsed phase conjugate mirror would be an analog a sequence of ordinary mirrors. Pulses create a temporal sequence of time mirrors most naturally located at the ends of pulses so that positive energy photons from N:th pulse annihilate withe negative energy photons from $N + 1$:th pulse.

Remark: More after-wisdom developed during 2 decades. ZEO guarantees classical conservation laws. What about the situation at quantum level? Could the energy associated with the positive energy part of zero energy state increase in quantum transitions and lead to over-unity effects? In principle, conservation laws do not prevent this quantally.

1. Recall that zero energy states [K7] [**?**] are identified as superpositions of pairs (a, b) formed from states a and b having opposite total quantum numbers and being assigned with the opposite boundaries of causal diamond (CD). The states at the passive boundary B of CD

are not affected whereas the states at the active boundary A are affected by a sequence of unitary time evolutions also shifting A farther away from B (in statistical sense at least).

Each unitary evolution induces a de-localization of A in its moduli space and "small" SFR induces its localization (including time localization meaning time measurement). This sequence would approximately conserve the energies of the states in the superposition. This in the approximation that their energies are large in the energy scale $\Delta E = \hbar_{eff}/Deltat$ defined by the time increment Δt in single unitary time evolution. Large value of h_{eff} makes the conservation worse for a given Δt. Unitarity together with the approximate energy conservation implies that the average energy is approximately conserved.

2. Negative energy signals sent from A to its geometric past and received at B in remote metabolism would correspond to "big" SFR. If the notion of remote metabolism giving effectively rise to over-unitary effect is to make sense, the approximate energy conservation should fail in "big" SFRs in quantal sense. For this to be the case, the first unitary evolution of B followed by "small" SFR energy conservation should be a bad approximation. This does not however seem plausible if one assumes energy conservation for the next state function reductions. What could be so special in the first state function reduction?

3. Why the energy conservation made approximate by the finite size of CD and finite duration of unitary evolution, should fail badly in some situations? According to the number theoretic vision [K1], "small" SFRs preserve the extension of rationals defining the adele and therefore also $\hbar_{eff}/\hbar_0 = n$ identifiable as the dimension of the extension. $\hbar_{eff}/\hbar_0 = n$ can however change $n_{old} \to n_{new}$ in "big" SFRs forced to occur when "small" SFRs preserving n_{old} are not anymore possible. If a large increase of h_{eff} occurs in the "big" SFR, the $\Delta E = \hbar_{eff}/Deltat$ increases if Δt is still of the same order of magnitude. The approximate energy conservation could fail badly enough to make possible remote metabolism.

4. In the subsequent SFRs energy conservation should however hold true in good approximation. The values of Δt should be large in the subsequent "small" SFRs, and Δt should scale as $\Delta t \propto n$ to guarantee that ΔE remains the same. As a quantum scale Δt analogous to Compton length is indeed proportional to n. In the first reduction one must have of $n = n_{old}$ but in the subsequent reductions one must have $n = n_{new}$ to guarantee energy conservation in the same approximation as before.

   To sum up: in the first "small" SFR one should have $\Delta E \propto n_{new}$ and $\Delta t \propto n_{new}$. Can one really deduce this from the basic TGD?

5. ZEO suggests that evolution [**?**] means a continual increase of the size of CD so that small CD could eventually grow to even cosmic size (whether this occurs always or whether zero energy state can become pure vacuum at both boundaries of CD remains an open problem). CD with a cosmic size should however have huge energy. This would not only require non-conservation of energy in quantal sense but also its increase in statistical sense at least. Why should the energy increase?

   The increase would relate directly to the basic defining property of ZEO. Preferred time direction means that the transfer of energy quantum numbers can take place only from the active boundary of CD to the passive boundary in "big" SFR. This allows interpretation as remote metabolism implying increase of the magnitude of energy.

Remark: Error correction has turned out to be major problem in the attempts to construct quantum computers. It is believed to be necessary because quantum entanglement is extremely fragile for the standard value of Planck constant. In TGD the situation changes. Large values of h_{eff} increasing the time scale of entanglement are possible and reversed time evolutions in quantum sense imply second law in reversed time direction meaning spontaneous reduction of entropy in the standard time direction. Nature itself would provide the needed error correction mechanism perhaps applied routinely in living systems (for instance, to correct mutations of DNA and transcription and translation errors).

2.2.3 TGD based description for the interference of reference beams

It is interesting to find whether TGD allows the field pattern resulting as a superposition of reference beams moving in opposite direction as a solution of field equations. Topological light rays do not allow this kind of field patterns. As a special case this field pattern corresponds to a transversal standing wave of form $cos(\omega t) \times cos(\omega z)$ (using units $c = 1$). Waves for which the interference pattern moves (say in the case of stimulated Brillouin scattering), result when the frequencies are different. These field patterns are obtained as Lorentz transforms of the standing wave pattern.

Since the Kähler current vanishes for this kind of waves the field equations state that the contraction of the energy momentum tensor with the second fundamental form vanishes. It will be found that the field equations reduce to massless wave equation in the approximation that classical gravitational effects are negligible. It is however not clear whether this kind of solution is possible as genuinely asymptotic self-organization pattern having a precisely vanishing Kähler current.

The solution ansatz is based on the assumption that the CP_2 projection belongs to the homologically non-trivial geodesic sphere S^2 of CP_2. Let the standard spherical coordinates of S^2 be $(U \equiv cos(\theta), \Phi)$. Let M^4 coordinates be (t, z, x, y), The task is to imbed the electric field representing a standing wave and having components

$$E_i \quad = \quad \epsilon_i \times cos(\omega t) \times cos(\omega z) \quad , \tag{2.1}$$

as a four-surface to $X^4 \subset M^4_+ \times S^2$. The polarization vector ϵ_i lies in the (x, y)-plane.

The 4-vector potential associated with this field is

$$A_\mu \quad = \quad \frac{\epsilon_\mu}{\omega} \times sin(\omega t) \times cos(\omega z) \quad . \tag{2.2}$$

Note that the scalar potential $\phi = A_t$ vanishes. The induced Kähler gauge potential is of form

$$A_\mu \quad = \quad U \partial_\mu \Phi \quad , \tag{2.3}$$

and from this the simplest ansatz (fixed only apart from a canonical transformation of CP_2) reproducing A_μ is

$$U = a \times sin(\omega t) \times cos(\omega z) \quad , \quad \Phi = b \times \epsilon_\mu x^\mu \quad , \quad ab = \tfrac{1}{\omega} \quad . \tag{2.4}$$

In the approximation that the induced metric is flat, action density vanishes, and the energy momentum tensor has only the longitudinal components T^{tt} and T^{zz} and is proportional to the flat metric. Field equations reduce to massless wave equation in longitudinal degrees of freedom: $D^2 u = 0$ and $D^2 \Phi = 0$, $D = \partial_t^2 - \partial_z^2$. For the proposed solution ansatz they are satisfied identically.

The fact that solution has a 2-dimensional CP_2 projection means that it represents a self-organization pattern with dissipation only due to the possible non-vanishing of the Kähler 4-current and characterized by the strength of classical gravitational interaction. Classical gravitation might imply a non-vanishing Kähler four-current.

2.3 Pulses, Tesla Transformers, And Binary Coils

The function of quite a many free energy systems involve sharp pulse sequences. Often the bi-filar coil invented by Tesla [H2] are used. Also Caducceus coil having also binary structure is utilized. Together with general TGD based vision this leads to a theoretical picture allowing to understand the visions of Tesla theoretically.

2.3.1 The vision briefly

A very concise summary of the model goes as follows.

1. The basic prediction of TGD are negative energy topological light rays propagating backwards in geometric time. They can be accompanied by self-generated negative energy photons since in general case topological light rays carry light like vacuum 4-current. The interpretation as counterparts of phase conjugate laser waves [D4] seems to make sense. A sequence of pulses carrying a constant electric field forces current carriers to accelerate repeatedly provided the frequency of the pulses is sufficiently low for charged to come at rest. A decelerating system emits its energy as positive energy photons whereas the accelerating system might receive its energy by emitting negative energy photons if deceleration and acceleration are genuine time reversals of each other.

2. Negative energy photons are absorbed by any system which contains (possibly many-sheeted) population inverted lasers with appropriate excitation energy when bosonic particles return to their ground states. If sufficiently many bosonic particles return to the ground state, a phase transition return to the ground state occurs and is analogous to induced emission. Large number of positive energy photons are generated and a weak negative energy control signal is amplified to much stronger positive energy signal. The resulting energy is identifiable as "free energy".

The generation of negative energy photons breaks second law. In TGD Universe second law however holds true at a given p-adic length scale only in time scales longer than the corresponding p-adic time scale. This means that field patterns having a duration below the relevant p-adic time scale can appear as negative energy topological light rays. Sharp electric pulses carrying a constant electric field are ideal in this respect.

Suppose that electric pulses are fed into a binary coil for which the loops of the primary and secondary coils are on top of each other and very near to each other. Electric pulses induce currents in the primary coil. Due to the large mutual inductance between loops of the primary and secondary coils composing the binary coil, the current generated by the pulse in the primary loop is transmitted inductively to the nearby second loop, which in turn generates a positive feedback to primary. Thus the current is amplified and the propagation of the electric pulse induces a propagation of large rapidly varying currents in coils rotating in opposite direction so that the magnetic flux inside the binary coil is small. First of all, this means that the sequence of electric pulses induces a currents through the two components of the binary coil by effectively reducing the inductance of the coil. Secondly, the amplification of the current means amplified acceleration of the current carriers optimal for the generation of negative energy photons as time reversed brehmstrahlung.

There are good reasons to expect that living matter has discovered the analogs of binary coils long before humans, even before Tesla. Binary structures, such as DNA double strand and cell membrane consisting of two lipid layers, are good candidates for the counterparts of binary coils and might play key control in the bio-control by serving as generators of negative energy photons in turn controlling the generation of positive energy photons.

2.3.2 Do electric pulses generate scalar wave pulses?

Interesting questions are related to the behavior of the electric field inside ordinary coils, binary coils, and in particular bi-filar coils. It seems that the expressive power of Maxwell's theory might not be enough here. It seems that the electric pulses propagating in any circuit could correspond to TGD counterparts of Tesla's scalar wave pulses.

1. The unipolar electric field is discontinuous at the ends of an ideal square pulse. In Maxwell's equations the rotor of the magnetic field equates to the sum of the current term j and the displacement current $\partial E/\partial t$. Either an infinitely sharp induction peak is allowed in the magnetic field or the displacement current must be compensated by the current term. In realistic case there is short rising time during which electric field increases.

2. In Maxwell's electrodynamics a very high (ideally infinitely strong instantaneous) ohmic current would be needed to compensate the displacement current. This seems implausible. In TGD however vacuum charges and currents are possible. The electric square pulse is analogous to a moving capacitor and the charges of the capacitor plates correspond to vacuum

charges. At the level of space-time geometry the plates would correspond to propagating edges of the 3-surface. The induced electric field E_{rot} would induce a current pulse, whose direction would change in the middle of the magnetic pulse.

3. TGD indeed predicts the existence of scalar wave pulses [K2]. These pulses represent electric flux quanta, 3-surfaces inside which there is an almost constant longitudinal electric field. A capacitor moving with the velocity of light would be the analogy. These solutions are not possible in Maxwell's theory. Because also the pulses moving in circuits are very similar, there is a temptation to identify them as scalar wave pulses. In this case the effective propagation velocity is reduced below light velocity by the interaction with matter. Intuitively, the particles topologically condensed in the region of 3-surface representing the pulse make it massive and slow down the effective speed of propagation.

4. The first guess that a scalar wave pulse of duration τ results when a voltage in circuit is switched on for time τ, does not make sense since the pulse could last for a an arbitrarily long time and have arbitrarily long length. Experimental study of a pulsed system involving a FET serving as a switch and a capacitor in parallel suggests that a positive energy scalar wave pulse results in switching on and has a duration equal to the rising time τ_r of the voltage. Negative energy scalar wave pulse moving into geometric past results in the switching off of the voltage. In switching on the capacitor absorbs a negative energy scalar wave pulse coming from geometric future and is neutralized. In the similar manner the capacitor in future re-charges by absorbing positive energy pulse from the geometric past.

5. An interesting question is whether scalar wave pulses propagating through (say) bi-filar coil could increase its capacitance dramatically by providing primary and secondary coils with opposite vacuum charges. If scalar wave pulse collects also ordinary charge on its "plates" when it moves through the system, it could become a dynamical capacitor, and transform also the system through which it traverses to a capacitor. The experimentation with bi-filar coil indeed forces to conclude that its capacitance can be much larger than expected on basis of geometric arguments.

6. One might imagine that the scalar wave pulses could leak out of the system. For instance, this might happen if the second end of the coil is free. Tesla indeed reported a production of scalar wave pulses using a transformer whose primary coil was fed by a sequence of unipolar pulses. These pulses were amplified in a secondary coil in whose second end was free. Abnormally high voltage amplification with no current in secondary coil was reported [H1].

7. If the propagation velocity of the scalar wave pulse is light velocity, the time T would be the time taken by the pulse to propagate through the first half of the bi-filar coil: $T = Z/v$, where Z is the length of the wire in the bi-filar coil and $v = c$ is light velocity. For $v = c$ T would be 3.3 ns if the length of the wire is 1 meter. The interaction with the matter induces inertial effects and is expected to reduce the effective propagation velocity of the scalar wave pulse representing the electric pulse to $v < c$.

2.3.3 Could electric pulses in circuits correspond to separate space-time sheets?

Scalar wave pulses could correspond directly to the space-time sheets of electric flux quanta moving with light velocity predicted by TGD [K2] rather than being regions of constant electric field at the space-time sheet of wire. These flux quanta would move along wire and have flux tubes connecting the space-time sheet of the flux quantum with the boundaries of small co-moving holes associated with the circuit's space-time sheet. Charged particles could flow to the flux quantum along these bridges at the first end of the electric flux quantum, accelerate there practically without dissipation, and flow possibly also back at the second end of the flux quantum. The direction of the flow would be determined by the sign of the charge. This would allow anomalous acceleration of the current carriers making it possible to emit negative energy photons up to energies determined by the voltage difference associated with the flux quantum. The lowering of the effective propagation velocity would be a genuine quantum effect based on the same mechanism as the lowering of the effect phase velocity of topological light rays.

The energies of the "acceleration radiation" would be quantized since the quanta would have frequencies $f_n = n/T_p$, where T_p is the duration of the scalar wave pulse. The duration of the scalar wave pulse should correspond to a natural time scale associated with the generation of the scalar wave pulse. For instance, if the scalar wave pulse is generated when a voltage in a circuit is rapidly switched on, the scalar wave pulse would naturally correspond to the rising time τ_r of the voltage. This quantization is a unique signature of the negative energy radiation.

Scalar wave pulse is like a moving capacitor and should be attracted or repelled by a real charged capacitor depending on the sign of its polarization. Therefore scalar wave pulse could be reflected from a heavily charged capacitor and begin to move forth and back around the loop connecting the plates of the capacitor in a circuit. The pulse could even move between capacitor plates forth and back. If binary coil is coupled between the capacitor the pulse should move forth and back through it. If scalar wave pulses correspond to separate space-time sheets they can leak out of the system. The open ends of the secondary coils used by Tesla in his transformers might be the places where the leakage occurs. The emission of a new kind of radiation observed by Modanese and Pokletnov [H3] to accompany the discharge of a capacitor for which the negatively charged plate was super-conducting might represent the emission of scalar wave pulses [K2] .

2.3.4 Scalar wave pulses as producers of phase conjugate waves and time mirror mechanism

Tesla transformers use ordinary coils as primary coils and an open coil as a secondary coil. On basis of his experimental work Tesla claimed that Tesla transformers allow an anomalously high voltage amplification. Strangely, Tesla found no current in the secondary coil but the transformers induced charging of various metallic objects in large regions surrounding the transformer. This effect was able to penetrate even through Faraday cage.

The bi-filar coils discovered by Tesla [H2], which are fed by sharp unipolar electric pulses carrying constant electric field and analogous to moving capacitors, occur repeatedly in various free energy devices. Caducceus coil is second binary coil appearing very often. This would suggest that coils with a binary structure somehow produce phase conjugate laser waves (negative energy topological light rays accompanied by negative energy photons). These in turn would induce the dropping of bosonic charged particles to larger space-time sheets as a phenomenon analogous to induced emission when the intensity of negative energy photons is above some threshold.

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

In the following early version of the model assigning metabolic energy quantum to the dropping of protons is considered. In [K8] a model of metabolism associating the metabolic energy quantum to the change of cyclotron energy is discussed. The challenge is to understand how square pulses propagating both in ordinary and binary coils manage to produce phase conjugated light.

What is so special in the unipolar electric pulses circulating in binary coils? If one wants to produce negative energy photons, one must break the second law of thermodynamics. TGD predicts that in a given n-ary p-adic length scale $L(n,k)$ (size of the space-time sheet) this is possible below the n-ary p-adic time scale $T(n,k) = L(n,k)/c$. One must only produce pulses having duration shorter than the p-adic time scale $T(n,k)$. The sharp electric pulses are excellent candidates for this kind of pulses since they accelerate the current carriers and during this period they can emit negative energy photons as "acceleration radiation" with quantized frequencies $f_n = n/T_p$, T_p the duration of the scalar wave pulse. If the pulses correspond to their own space-time sheets dissipation is negligible and the intensity of acceleration radiation is maximal.

An especially interesting situation arises when the energies of the negative photons radiated by the charged particles accelerated inside the scalar wave pulse correspond to the increment of a zero point kinetic energy for some charged particle when it drops to a larger space-time sheet. In this case the negative energy radiation could make possible time mirror mechanism by generating a cascade like dropping of charged particles and an amplified emission of positive energy photons.

This hypothesis is testable by choosing suitably the value of the rising time τ_r.

There are natural time scales associated with pulsed binary coils. One class of important frequencies would correspond to harmonic multiples for the frequency $f = 1/\tau_p$, the duration of electric pulse. Second time scale corresponds to the frequency defined by the duration of the scalar wave pulse and is assumed to correspond to the rising time τ_r of the electric pulse. A second important time scale is the time interval between the pulses which must be so long that the charges have time to come at rest. One expects that this time scale is of the order of $\tau = L/R$, where L and R characterize the primary of the binary coil. A third important time scale is the duration of the magnetic pulses generated in the pulsed binary coil. Besides these time scales important time scales are the time scales determined by the basic parameters L, C, R of the primary (secondary) of the binary coil.

As far as I know, Tesla used ordinary coils in his transformers and observed anomalous voltage amplification and other strange effects. If the time interval between voltage pulses is so long that the charges dissipate their energy, charges are indeed accelerated in a constant electric field and the emission of negative energy photons should occur. Hence also ordinary pulsed coil, perhaps when used as the primary of the Tesla transformer, could allow the exotic effects due to the generation of negative energy photons. In particular, if this process leads to the phase transitions increasing the conductivity of the wire then the current in the primary coil increases and therefore also the current in the secondary coil increases beyond the value predicted by Maxwell's theory.

2.3.5 Bio-systems and unipolar pulses

One might think that besides Tesla also bio-systems might have invented the sharp pulses as a way to break second law temporarily and produce negative energy topological light rays crucial for all basic mechanisms in TGD based quantum biology and theory of consciousness. Perhaps one function of nerve pulse is to produce phase conjugate waves and perhaps nerve pulse can be switched on by a scalar wave pulse reducing the membrane potential below the critical value.

This suggests the existence of biological variants of binary coils. Bio-systems are full of binary structures such as DNA double strand and cell membrane (consisting of two lipid layers). It is tempting to think that DNA double strand is a variant of bi-filar coil in which scalar wave pulses propagate along strand (associated with say gene) and return along the conjugate strand. Also now the effective inductance of the system would grow from zero to some maximum value and return back to zero and phase conjugate light would be generated. As a matter fact, the TGD based model for bio-photons lead to the hypothesis that the strand/conjugate strand generates positive/ negative energy MEs and that these MEs move in opposite directions along strands [K6].

2.4 Could Negative Energy Photons Induce The Transition To Effective Superconductivity?

The generation of negative energy photons involves temporary breakdown of the second law. Therefore the minimization of the resistance of the relevant part of the circuit, say binary coil, should be favorable for the effect.

TGD based new physics might provide a possible mechanism reducing the resistance. If part of the current carrying electrons of the bi-filar coil drops down to the larger space-time sheets, where they propagate as Cooper pairs, the resistance of the system is reduced. The research group led by Hafedh Abdelmeik has found that the electric conductivity of axon grows by a factor of order 10 below a certain critical temperature, which is in the range 30-40 C of physiological temperatures [J3]. The TGD based model [K10] explains the findings correctly at quantitative level.

A variant of this mechanism might be at work also in the case of electric circuits if appropriate conditions are satisfied.

1. The model for the realization of intentionality and motor activity [**?**] relies on a process, which proceeds from long to short time and length scales, much like a desire for some action in an organization proceeds from boss to the bosses at lower level. In the same manner a hierarchy of phase transitions could proceed from longer to shorter length and time scales and reduce the resistance and increase the upper limit for the energy of negative energy photons.

2. The pulses propagating in the binary coil could produce already in the normal situation a sufficient amount of negative energy photons at low frequencies to induce a phase transition increasing the conductivity. The growth of the intensity of the negative energy photons emitted at higher frequencies could in turn induce a similar phase transition in a shorter p-adic length scale and corresponding to higher zero point kinetic energy. At every stage the negative energy photons could first cool the system so that the phase transition occurs more easily. The dropped Cooper pairs would in turn increase the portion of the supra current flowing at the ground state space-time sheet and thus conductivity.

Remark: All these models could be formulated in terms of ZEO and the notion of many-sheeted space-time. In particular, the analog of scalar wave as a pair of massless extremals (MEs) with same momenta and opposite polarization makes sense in TGD framework. The effects of this kind of configuration on test particle is like that of scalar wave. Also the analogs of waves propagating with arbitrary small velocity and even of standing waves make sense as pairs of MEs with opposite momentum directions.

3 The Scalar Waves Of Tesla In TGD Framework

The scalar waves or so called non-Hertzian waves of Nikola Tesla belong to the fringe region of science. Many proponents of free energy believe that scalar waves might provide a basis for a new energy and communication technologies. Tesla himself was isolated from the official science and found no place in text books because his hypothesis about scalar waves did not fit within the framework of the Maxwell's electrodynamics. Personally I justified my personal prejudices against scalar waves by the observation that the formulations for the notion of scalar waves that I had seen seemed to be in a conflict with the cherished gauge invariance of gauge theories. The discussions with a Finnish free energy enthusiast Juha Hartikka however led me to reconsider the status of the scalar waves.

The surprise was that the non-Hertzian waves of Tesla might be possible in TGD framework. One can imagine two alternative ways to obtain them.

1. TGD allows so called massless extremals (MEs, topological light rays) as non-linear generalization of Maxwellian plane waves. They are characterized by light-like wave vector and polarization vector orthogonal to it and these vectors can also depend on space-time position [K3]. The most general wave is a pulse with arbitrary profile moving along ME with light-velocity along them and preserving its shape.

   Since TGD space-time is many-sheeted one can take two waves of this kind on top of each other in the sense that their M^4 projections intersect in some region of M^4. The effective space-time is defined by a piece of Minkowski space with effective metric which is sum of M^4 metric and deviations of the metrics of sheets from M^4 metric. Effective gauge potentials are sums of the induced gauge potentials. For two MEs the potentials at the two sheets and if the wave vectors can be chosen to be in opposite direction in which case one obtains an effective standing wave with non-vanishing net energy but vanishing 3-momentum and classical spin. Since MEs can carry light-like charge current the resulting system carries non-vanishing charge density and vanishing current Fourier transforms of the pair give rise to massive spinless states having identification as scalar waves possibly carrying em charge.

   In TGD framework classical gauge boson fields of standard model correspond two-sheeted structures - perhaps pairs of MEs connected by wormhole contact pairs having interpretation as gauge boson. One can consider the possibility that the classical space-time correlate for gauge bosons massivation at the level of MEs is this kind of pair of spacetime sheets. For massive gauge bosons the wave vector directions of the two sheets would be opposite in the rest system and spin would be vanishing.

2. The original proposal could have been inspired by the electric-magnetic duality of TGD suggesting a large number of solutions of field equations representing constant energy density configurations of electric field assignable to bio-electrets, which would be in a well-defined sense dual to the magnetic flux tube structures with analogous properties. Also classical

gravitational fields generated by classical field energy could be important in the living matter. One must however take this proposal with a big grain of salt since there is no proof for the actual existence of this kind of solutions. Furthermore, one can obtain TGD counterparts of scalar waves as pairs of MEs.

In the following only the candidate for scalar waves obtained as single-sheeted space-time is considered.

3.1 The Properties Of The Scalar Waves

Perhaps the most important properties of the scalar waves are following.

1. Scalar waves involve some kind of oscillatory process in the direction of the propagation of the wave. The analogy with sound waves suggests that the oscillation could relate to charge density, or more generally to 4-current in the direction of the wave. Even massless extremals (MEs), which are essentially topological light rays, involve vacuum current and vacuum charge density which oscillates in the direction of propagation.

2. Scalar waves are believed to carry electric field in the direction of the wave motion so that the identification of MEs as scalar waves is not possible. The presence of only electric field means that scalar wave is characterized solely by the scalar potential. This kind of solution is excluded by the gauge invariance and linearity of Maxwell's electrodynamics in vacuum.

3.2 Could Nonlinearity Of TGD Allow Scalar Waves?

One is led to ask whether the nonlinearity of TGD might allow existence for scalar waves.

1. In TGD based electrodynamics CP_2 coordinates are the primary dynamical degrees of freedom gauge fields being secondary dynamical variables induced from the spinor curvature of CP_2. Field equations are extremely nonlinear allowing among other things vacuum 4-currents (even Faraday's unipolar generator involves vacuum charge density changing its sign when the direction of rotation of magnet changes its sign). This gives hopes about finding solutions of field equations with the properties assigned to the hypothetical scalar waves.

2. Interestingly, in TGD framework the canonical symmetries of CP_2 are dynamical symmetries and act as isometries of WCW of 3-surfaces. Canonical transformations act formally as $U(1)$ gauge transformations but, rather than being gauge symmetries, they are dynamical generating new physical configurations and are partially responsible for the quantum spin glass degeneracy of the TGD universe. As a matter fact, also diffeomorphisms of M^4 act as dynamical symmetries in the lowest order.

3. Magnetic flux tubes represent fundamental solutions of field equations and the simplest magnetic flux tubes can be characterized as maps from a region of a 2-dimensional Euclidian hyperplane E^2 of Minkowski space to a geodesic sphere S^2 of CP_2.

4. Electric-magnetic duality is a fundamental symmetry of the WCW geometry. Therefore there should exist solutions dual to the magnetic flux tubes carrying only electric fields and perhaps allowing interpretation as waves. These solutions would be characterized by a map from a region of the Minkowskian hyperplane M^2 of Minkowski space to S^2. This kind solution ansatz makes sense since it formally provides the solutions of a field theory from M^2 to S^2.

3.3 Lowest Order Solution Ansatz

One can write the field equations explicitly. They are however extremely nonlinear and without physical intuition one cannot say much about the solution spectrum of these equations. One can however make simplifying assumptions to get grasp to the problem.

1. The effect of classical gravitation can be assumed to be extremely weak except possibly at some singular regions associated with the solutions.

2. In Maxwellian theory without sources gauge current vanishes identically. This would suggest that it is good to start from a zeroth order solution ansatz with this property so that the non-vanishing of the vacuum current would be solely due to gravitational effects. It deserves to be noticed that Tesla proposed also that non-Hertzian radiation fields involve a kind of radiation charge.

   In principle, one can imbed a portion of any solution of Maxwell's equations in empty space as a space-time sheet (note the occurrence of the topological quantization) using M^4 coordinates as preferred coordinates. Field equations are satisfied in the lowest order in R^2. The canonical symmetries of CP_2 act as dynamical symmetries for these solution ansätze and one obtains infinite degeneracy of the space-time surfaces representing the same Kähler field.

3. Constant electric field represents the simplest field configuration one can imagine. Therefore it is reasonable to start with this kind of solution ansatz and to look whether gravitational corrections affect the solution and bring in the wave aspect.

4. Since wave motion is hoped to result, it is useful to choose the space-time coordinates in an appropriate manner. Light-like coordinates (x^+, x^-, x, y) of M^4 are thus very natural. They are defined by the conditions

$$t = (x^+ + x^-)/2 \ , \quad z = (x^+ - x^-)/2 \ ,$$

   with (t, x, y, z) referring to the linear Minkowski coordinates such that t is time coordinate. In these coordinates the line element of M^2 has the form $ds^2 = -2dx^+dx^-$ so that one has $g_{+-} = -1$.

5. Using the spherical coordinates $(u = cos(\Theta), \Phi)$ for the geodesic sphere S^2 of CP_2, the zeroth order solution ansatz has the following form:

$$u \equiv u_0 = \omega_1 x^+ \ , \quad \Phi \equiv \Phi_0 = \omega_2 x^- \ . \tag{3.1}$$

   Since electromagnetic, Z^0 and color fields are proportional to Kähler form for the solution type considered, one can restrict the consideration to the induced Kähler form. Denoting the Kähler form of CP_2 by J_{kl}, by noticing that S^2 Kähler form is given by $J_{u\Phi} = 1$ (forgetting the precise normalization factor), and using the expressions $\left[s_{uu} = R^2/(1-u^2), s_{\Phi\Phi} = R^2(1-u^2)\right]$ for the metric of S^2, one can write the induced line element and the non-vanishing component of the induced Kähler form as

$$\begin{aligned} ds^2 &= -2dx^+dx^- + \frac{R^2\omega_1^2}{1-u^2}(dx^+)^2 + R^2\omega_2^2(1-u^2)(dx^-)^2 - dx^2 - dy^2 \ , \\ J_{+-} &= \partial_+ u \partial_- \Phi = \omega_1\omega_2 \ , \\ J^{+-} &= \frac{\omega_1\omega_2}{det(g)} \ . \end{aligned} \tag{3.2}$$

   Since the determinant of the induced metric is constant, J^{+-} describes constant electric field and that Kähler current j^α is vanishes. This means that Maxwell's equations hold true in the zeroth order approximation as required.

Apart from the normalization factors the energy momentum tensor in the longitudinal degrees of freedom is given by

$$T^{\alpha\beta}(long) = g^{\alpha\beta}L/4 \ ,$$

In the transversal degrees of freedom similar expression but with opposite sign holds true. Here L is Kähler action which is essentially electric energy density and constant.

In M^4 degrees of freedom the field equations express conservation of the energy momentum currents and are satisfied to order R^2 since the action is constant. These equations imply that action density is constant. This forces to ask whether all perturbatively constructible solutions represent a constant Kähler electric field locally.

In CP_2 degrees of freedom field equations involve a sum of two terms: the first term involves the contraction of the energy momentum tensor with the second fundamental form whereas the second term involves Kähler current. Since Kähler current vanishes, the latter term vanishes and one can say that field equations are satisfied in zeroth order approximation (the term involving energy momentum tensor is proportional to CP_2 length squared and thus small). For exactly vanishing vacuum current the field equations would reduce to the equations for a minimal surface:

$$g^{\alpha\beta} D_\beta \partial_\alpha h^k = 0 \ , \tag{3.3}$$

where the embedding space coordinates h^k corresponds to u and Φ now. The same equations result also in M^4 degrees of freedom by requiring that the terms of order R^2 in the equation for the energy momentum conservation vanish.

This equation is not satisfied exactly as is easy to see. The non-vanishing components of the trace of the second fundamental form are given by

$$\begin{aligned} g^{\alpha\beta} D_\beta \partial_\alpha u &= -\{ {}^{u}_{\Phi\ \Phi} \} \omega_2^2 \times \left[1 - g^{++} \omega_1^2 R^2/(1-u^2) \right] \ , \\ g^{\alpha\beta} D_\beta \partial_\alpha \Phi &= -\{ {}^{\Phi}_{u\ \Phi} \} \omega_1 \omega_2 \times \left[1 - g^{--} \omega_2^2 R^2 (1-u^2) \right] \ . \end{aligned} \tag{3.4}$$

Here $\{ {}^{\alpha}_{\beta\ \gamma} \}$ denote the components of the Riemann connection for sphere. It is seen that the connection term gives contributions which vanish only at $u = 0$ which corresponds to the equator of the geodesic sphere S^2. At poles the minimal surface condition fails to be satisfied.

3.4 First Order Corrections To The Solution Ansatz

To take into account gravitational corrections one must modify the solution ansatz in such a way that x^- does not appear in the field equations at all: this guarantees that field equations reduce to ordinary differential equations. The modification is following:

$$u = u_0 + u_1(x^+) \ , \quad \Phi = \Phi_0 + \Phi_1(x^+) \ . \tag{3.5}$$

The modification affects the electric field and vacuum current and allows the compensation of the terms resulting form the contractions of the energy momentum tensor and vacuum current. The modification means that wave equations are still satisfied for u and Φ. Note that second fundamental form does not contain second derivative terms in the lowest order approximation.

The derivation of the differential equations for u_1 and Φ_1 is completely straightforward but requires some patience with numerical factors (reader should check sign factors and numerical factors).

1. Calculate the current contraction term

   $$j^\alpha \left[J^k_r \, \partial_\alpha h^r - J^\mu{}_\alpha \partial_\mu h^k \right]$$

   and energy momentum tensor contraction term

   $$T^{\alpha\beta} D_\beta \partial_\alpha h^k$$

   and equate these terms. Effective two-dimensionality makes the explicit calculations relatively simple.

2. The equations for u and Φ in terms of $j^{\pm}$ read as

$$j^-(1-u_0^2)+j^+\epsilon_1\epsilon_2 = \{{}^{u}_{\Phi}{}_{\Phi}\}\frac{K\epsilon_2^2}{2} \equiv X_1 \ ,$$

$$j^+\frac{1}{(1-u_0^2)}j^-\epsilon_2^2 = -2\{{}^{\Phi}_{u}{}_{\Phi}\}K\epsilon_1\epsilon_2 \equiv X_2 \ ,$$

Here the notations $\epsilon_i = \omega_i R$ and $K = \omega_1\omega_2^2$ are used. Linear second order differential equations are in question with the right side serving as an inhomogenuity term.

3. One can solve j^+ and j^- from these equations to get

$$\begin{pmatrix} j^+ \\ \\ j^- \end{pmatrix} = \frac{1}{\epsilon_1\epsilon_2^3-1} \times \begin{pmatrix} \epsilon_2^2 & -(1-u_0^2) \\ \\ -1/(1-u_0^2) & \epsilon_1\epsilon_2 \end{pmatrix} \times \begin{pmatrix} X_1 \\ \\ X_2 \end{pmatrix} \equiv \begin{pmatrix} Y_1 \\ \\ Y_2 \end{pmatrix}$$

From this form one can see that j^- becomes singular at $u_0 = \pm 1$ as $1/(1-u_0^2)$ which means that light-like vacuum current is generated. The physical interpretation is that vacuum charge density at these points which correspond to the boundaries of the solution acting as the source of the vacuum electric field is in question.

4. One can calculate $j^{\pm}$ by calculating the covariant divergence of the induce Kähler field in the lowest non-trivial order. The calculation gives the following expression

$$\begin{pmatrix} j^+ \\ \\ j^- \end{pmatrix} = \omega_1 \begin{pmatrix} u_0\partial_+^2 u_1 + \epsilon_1\epsilon_2(1-u_0^2)\partial_+^2\Phi_1 \\ \\ \omega_1\epsilon_2\partial_+^2 u_1 - \epsilon_1(1-u_0^2)\partial_+^2\Phi_1 \end{pmatrix}$$

5. For u_1 one finds the equation

$$\begin{aligned} \partial_+^2 u_1 \ + \ & \epsilon_1\epsilon_2^2\omega_1 u_0\partial_+ u_1 = \frac{1}{\omega_1} \times (Y_1 + \epsilon_1 Y_2) \\ = \ & \frac{\omega_2^2}{2}\frac{\epsilon_1}{\epsilon_1\epsilon_2^3-1} \times u_0 \times \left[-\epsilon_2^4(1-u_0^2) + \epsilon_1\epsilon_2(-2+\epsilon_1) - \epsilon_1^3\epsilon_2\frac{1}{1-u_0^2}\right] \ . \end{aligned} \quad (3.6)$$

This equation reduces to a first order differential equation for u_1 and one can solve it by variation of integration constants. The singularity at $u = \pm 1$ implies a logarithmic singularity of the derivative

$$\partial_+ u_1 \sim log(1-u_0^2)$$

but u remains finite as it should.

6. One can integrate Φ_1 from the second order inhomogenous and linear equation

$$\begin{aligned} \partial_2^+\Phi_1 \ &= \ \frac{1}{\epsilon_1\epsilon_2(1-u_0^2)}\left[j^- - \omega_2\partial_+^2 u_1\right] \ , \\ j^- \ &= \ \frac{\omega_1\omega_2^2\epsilon_1\epsilon_2}{2(\epsilon_1\epsilon_2^3-1)} \times u_0 \times \left[1 - \frac{2\epsilon_1^2}{1-u_0^2}\right] \ , \end{aligned} \quad (3.7)$$

once the solution for u_1 is known. Note that the most singular part corresponds to $u_0/(1-u_0^2)^2$ type term and one obtains logarithmic singularity also now.

3.5 PropertiesOf The Solution Ansatz

The form of the differential equations for the first order corrections allows to conclude that the North and South poles of the geodesic sphere S^2 (the points $u_0 = \pm 1$) correspond to singularities of the solution. Both the components of the induced metric and the induced Kähler form become singular at these points. This means that classical gravitation becomes important near these points. These points correspond in the lowest order approximation to the lines $x^+ = \pm 1/\omega_1 \equiv T$ plus possibly the lines obtained by continuing the solution by assuming that $x^- = constant$ lines define a motion identifiable constant rotation along the big circle from $\theta = 0$ ($x_+ = T$) to $\theta = \pi$ ($x_+ = -T$) continuing in the same manner to $\theta = 0$ at ($x = 2T$) and so on. Therefore gravitational effects induce a periodical behavior of the solution such that gravitational effects become strong at $x^+ = (2n+1)T$.

In the next order electric field is not constant anymore and vacuum current is generated. The contravariant component of electric field, being proportional to $1/\partial_+ u$ near singularity, vanishes at the singularity whereas the tangential component j^- of the vacuum current diverges. The vacuum current should generate coherent photons.

By a straightforward calculation one finds that the curvature scalar behaves as $R \propto 1/(1-u_0^2)$ at the singularities so that the energy density of vacuum becomes singular and could generate a coherent state of gravitons. Since Einstein tensor vanishes identically in two-dimensional case, the longitudinal components G^{++}, G^{--} and G^{+-} of Einstein tensor vanish. The components of Einstein tensor in transverse degrees of freedom are given by $G^{alpha\beta} = -g^{\alpha\beta}R/2$. Therefore the energy momentum tensor defined by Einstein's equations would involve only space-like momentum currents. The singularity is amplified by the fact that field energy couples to the classical gravitation with coupling which is 10^8 times stronger than the ordinary gravitational coupling. The singularity might relate to the claimed gravitational anomalies associated with the scalar waves.

As already found, Einstein tensor and gauge current have no components in the direction of x^+. Energy-momentum tensor behaves as $1/det(g)^{3/2}$ at the end points of the interval $[-T, T]$ and thus vanishes. Therefore conservation laws allow to restrict the solution into the x^+ interval $(-T, T)$. This restricted solution defines geometrically a particle like structure moving in x^- direction but with fields moving in x^+ direction so that one would have rather exotic kind of particle-wave dualism. In accordance with the quantum-classical correspondence, one could interpret this as classical space-time representation of the particle wave duality and the solution would be a particular example of topological field quantization. Tesla stated that this non-Hertzian waves did not weaken with distance. This is indeed the case if one interprets the signal as a finite piece of space-time moving with light velocity.

3.6 More General Solutions Representing Electric Field Of Constant Action Density Are Possible

The solution ansatz just discussed represents a constant electric field in a region of space-time moving with ligth velocity in the direction of x^- coordinate. Also ordinary constant electric fied is a possible solution and is constructed iteratively in an essentially identical manner by starting from the solution ansatz

$$u = kz \ , \quad \Phi = \omega t \ . \tag{3.8}$$

Also now Kähler current vanishes in the lowest order and action density is constant so that lowest order field equations are satisfied. Higher order corrections are obtained using the ansatz $u_1 = u_1(z)$, $\Phi = \Phi_1(z)$. Minimal surface condition gives now essentially same kind of expressions for u_1 and Φ_1. Also now the singularities where gravitational interaction becomes strong are at $u = \pm 1$ and one can select the solution to represent a membrane like structure with thickness $L = 2/k$.

Cell membrane space-time sheets are good candidates for the realization of this kind of solutions. If so, one might expect that classical gravitational effects become important at the boundaries of the cell membrane. More generally, bio-systems are electrets and the proposed solution type might provide a fundamental model for bio-electrets. In particular, electro-gravitational effects due to the energy of the classical electric field might be of importance.

This observation relates interestingly to the sol-gel phase transitions occurring inside cell. In these transitions large scale bound states of water molecules are formed and could make possible macro-temporally quantum coherent systems able to perform quantum computations in time scales of order say .1 seconds. These bound states would be characterized by spin glass degeneracy broken only by the classical gravitation and spin glass degeneracy would make these bound states long lived. In the case of the proposed solution ansätze spin glass degeneracy corresponds to the canonical symmetries of CP_2 generating new solutions representing constant electric field.

Also M^4 diffeomorphisms are symmetries of the field equations broken only by the classical gravitation. Approximate diffeomorphism invariance means that one obtains solutions for which the lines of electric flux are curved and only the action density stays constant. In the case of magnetic flux tubes this symmetry makes possible curved magnetic flux tubes. Both electric fields and the magnetic flux tubes are fundamental for the TGD based model of living matter and relate deeply to the electric-magnetic duality symmetry and to the quantum criticality predicting that magnetic and electric space-time regions having opposite signs of Kähler action play a role similar to the ice and water regions at critical point of water, are important physically.

3.7 Support For Tesla's Scalar Waves/Classical Z^0 MEs

Recently I learned from Hans-Poul Veldhuyzen van Zanten that E. Podkletnov and G. Modanese have constructed a device [H3] in which a super-conducting ceramic catode and a copper anode cause electrical discharges in low pressure gases, at temperatures between 50 and 70 K. The voltage used is 2000 kV. Peak currents are of order 10^4 A. catode and anode have radii of 10 cm and their distance varies between 15 and 40 cm. There is also a magnetic field of.9 Tesla present inside the cylindrical chamber to concentrate the discharge to a smaller area. In discharges at voltage above 500 kV two new phenomena were observed. First, discharge does not look like a spark but like a flat, glowing discharge originating from the whole surface of the super-conductor. Secondly, a radiation pulse is emitted at the discharge which propagates orthogonally to the catode, towards the anode and beyond it, in a collimated beam, apparently without an attention. Radiation pulse carries away an energy of 10^{-3} J at least. It is concluded that the radiation in question cannot be ordinary electromagnetic radiation.

The anomalous radiation was measured using various penduli at the line connecting the centers of catode and electrode and hanging from a cotton string inside glass cylinders under vacuum. The radii of spheres were 10-25 mm and located at distances 6 m and 150 m from the installation. Various materials for the spheres were used: metal, glass, ceramics, wood, rubber, plastic. It was found that the impact on pendulum did not depend on the material but only on the mass of the pendulum which was in the range 10-50 g. Pendulum did not show any signs of heating. Measurements of the impulse taken at close distance (3-6 m) and large distance (150 m) gave identical results. The pulses where not absorbed by the media or at least, the losses of energy were negligible. The force beam does not seem to diverge and its borders are clear-cut and the width of the beam is that of the super-conducting emitter. If the pulse propagates in air, some energy should be depleted from it and lead to the weakening of the pulse. The observations of the air in the path of pulse only show that brief forward and backward movement of particles occurs.

The radiation appears to propagate through brick walls and metal plates without a noticeable absorption but this is not due to weak coupling with matter. Ordinary electromagnetic radiation cannot be in question. The assumptions that the radiation satisfies $E = cp$ dispersion relation and that the pulse given to the penduli is due to the absorption of energy and momentum of radiation leads to a contradiction. For a pendulum of 18.5 g, the kinetic energy of the pendulum was of the order of 10^{-4} J whereas the momentum was of the order of 10^{-3} kg m/s. If this momentum had to be imparted from the beam, its total energy should be larger than the total energy available in the discharge, 10^6 J in maximum. The conclusion made in [H3] is that the radiation does not obey the dispersion relation of massless particles. On the other hand, if the net energy and momentum of the pendulum correspond to the total energy and momentum for quanta of radiation absorbed by the pendulum, the quanta must be tachyonic since one has $E = 10^{-4}J \ll pc = 3 \times 10^5$ J, which suggests that absorption is not the mechanism. Also the fact that radiation does not weaken with distance with a detectable manner suggests the same.

The force is proportional to the mass of the pendulum sphere but the interpretation as a gravitational force is excluded already because of the strength of the effect. Equivalence Principle

states also that the gravitational force depends only on the gravitational mass of the particle, not its particular state. The force is also repulsive.

Consider now a TGD based explanation for the effect.

1. The radiation could correspond to a massless extremal (ME, "topological light ray") or TGD counterpart of the longitudinal scalar waves of Tesla. The classical field involved could be either electromagnetic or Z^0 type. MEs represent classical completely collimated radiation propagating with light velocity with pulse shape being arbitrary and preserved. Tesla wave represents longitudinal pulse of electric or Z^0 electric) field propagating with light velocity. At least Z^0 type and perhaps also em MEs and scalar waves do not care about Faraday cages: the classical radiation is simply at another space-time sheet. This fits with the observation that the pulse of radiation goes through various obstacles without absorption.

2. Electromagnetic Tesla's scalar waves are favored because their emission could be interpreted as a decay of the electric field of the capacitor by the emission of scalar waves carrying away pieces of space-time containing a constant electric field with intensity equal to the local intensity of the electric field between the capacitor plates. For the scalar wave pulses the quantization of the electric flux analogous to that of magnetic flux suggests that the condition

$$eVL = eEL^2 = n \times 2\pi \ ,$$

n integer, is satisfied ($\hbar = c = 1$), so that the length of the scalar wave pulse would be $L = \sqrt{n2\pi/eE}$. For an electric field having a magnitude of order $E \sim 10^4 kV/m$ (a voltage of 10^4 kV over a distance of 10 cm) and for $n = 1$ the scalar wave pulse would have a length of about one micrometer.

3. What might cause the repulsive force proportional to the mass of the object? $E = pc$ relationship does not hold for the energy transfer: rather momentum is much larger than this would allow. Thus an absorption of massless quanta is certainly not in question. Rather, the relationship suggests an ordinary non-relativistic dispersion relation between kinetic energy and momentum for a massive particle. The total mass of these particles is from numbers $\Delta E = 10^{-4}$ J and $\Delta p = 10^{-3}$ kgm/s equals to about 50 grams. The actual mass mentioned in the example was 18.5 grams. This makes perfect sense since only order of magnitude estimate is in question.

4. Many-sheeted space-time suggests a different explanation for the effect consistent with $E = cp$ relationship. The effect would be actually a special case of anomalies which are very abundant and explained by the many-sheeted space-time concept.

   (a) The space-time sheet of the pulse would act as a temporary bridge between two space-time sheets, say an atomic space-time sheet of the test object and a super-conducting magnetic flux tube of the Earth's magnetic field. Some particles from the atomic space-time sheets of the test object leak along this bridge to a larger space-time sheet or vice versa. The presence of the leaking particles at the bridge would make it temporarily massive and stop the motion of ME/scalar wave pulse for a moment. Since absorption does not occur considerably this should occur only temporarily. In case of the scalar wave pulse the longitudinal electric field would define a force field and induce ionic currents of opposite sign between the space-time sheets.

   (b) If the particles leak to the direction of the emitter first, as is natural since the flux tubes are first formed to this direction, then effective repulsive force results as a recoil effect by conservation of total momentum holding in many-sheeted space-time but not for single space-time sheet anymore. Recoil momentum is indeed non-vanishing since the zero point kinetic energy of particles at atomic space-time sheets is non-vanishing and is transformed to the kinetic energy of the particles at the larger space-time sheet. An order of magnitude estimate is obtained by assuming that the "dropping" particles are electrons, and that the zero point kinetic energy is $E = \pi^2/2m_eL^2 \simeq 1$ keV resulting, when the size L of the atomic space-time sheet is one Angstrom. This gives for the fraction ϵ of electrons in the pendulum transferred to the beam space-time sheet the estimate $\epsilon \simeq 1.8 \times 10^{-10}$.

(c) If the probability for leakage is same for all particles independent of the material, the recoil momentum of the object resulting from the leakage of particle to another space-time sheet is proportional to the mass of the object as observed.

A possible test for this effect is following one. The object should lose some mass via the leakage, at least temporarily. The loss of mass is predicted to be small, a fraction of order 10^{-13} about the mass of the pendulum. One could also look whether the pendulum becomes charged in the process. The leakage of the super-conducting ions from the magnetic flux tubes of say Earth to the atomic space-time sheets is a fundamental mechanism of breaking of super-conductivity in TGD universe. The quantum theory of bio-systems relies on this mechanism as well as TGD based explanations for certain free energy phenomena like Brown's gas [K6]). The "miraculous" appearance of ions or atoms to system originally not containing them by supra current leakage from magnetic flux tube space-time sheets (say) is the basic testable prediction.

4 Does The Model Explain The Basic Observations Of Tesla?

The basic vision of Tesla was that the sharp pulses involve physics not understood in the framework of Maxwell's theory. Tesla ended up with this vision on basis of certain empirical findings and it is interesting to find whether these observations could be understood in the proposed conceptual framework. In other words, could time reversal and the breaking of the second law below the p-adic time scales explain these findings.

4.1 Switching The Current On As A Time Reversal For Switching The Current Off

The basic observation of Tesla was that a sudden switching on of the current circuit produced strange phenomena. Besides sparks and light arcs strong charges were induced in the metal objects in environment. Physiological effects like electric shocks, pressure, sensations of heat, etc.. appeared. Also energy seemed to be liberated. The effects propagated through Faraday cage.

This kind of findings inspired Tesla to develop a technics to produce series of sharp pulses. In the system developed by Tesla, a magnet was repeatedly posed between the capacitor plates between which current was flowing to turn off the current for a moment. The outcome was a fast method for producing sharp current pulses. Tesla developed devices utilizing sharp pulses such as bi-filar coils and transformers, which produced much higher voltage in the secondary coil than one might have expected on basis of Maxwell's theory. The second end of the secondary coil was in freely in air and no current was observed at the end of the coil.

What was the source of these effects? The chapter "Rosetta Stone" in the book of Vassilatos [H1] contains a statement which gives a hint: when the current was switched on, the current carriers behaved as if they had collided with a wall and stopped for a moment. This sounds paradoxical since it is what one might expect to happen when the current is switched off so that resistance suddenly increases. Now just the opposite happened.

A possible solution to the paradox is provided by the reversal of geometric time. If the switching on of the current is time reversal of the switching off, the initial situation could be that the system is in a state resulting after closing off of the circuit and it might contain very high charge densities. The resulting high electric fields could even induce the evaporation of the wire. This would mean that the second law of thermodynamics would enter the game and the process would not proceed in the desired manner. In fact, it is not necessary to assume even this as following argument demonstrates.

Time reversal allows to understand what happens in the case that the time reversed process proceeds.

1. When the current is switched off, charge carriers decelerate and emit their energy as positive energy photons. When the current is switched on, charges accelerate and get their energy by emitting negative energy photons. If the system starts from a situation in which charges have "collided with a wall" the amount of energy needed is especially high. This is however not necessary.

2. Condensed matter like water or biological matter are full of population inverted many-sheeted lasers. At certain resonance frequencies corresponding to the differences of the zero point kinetic energies negative energy photons induce phase transitions discharging the population inversion of the many-sheeted laser. From certain space-time sheets charged "drop" to large space-time sheets, say magnetic flux tubes. A cascade of positive energy photons is liberated and manifests itself as "free energy".

3. The metallic (for instance) objects receiving negative energy photons lose net charge to the large space-time sheets and generate a net charge of opposite sign so that a high voltage with respect to the environment is generated. This indeed was found by Tesla to occur, and the charge definitely did not originate from the circuit generating the effect. This in fact led Tesla to postulate that ether carrying the charges was emitted in the process. Process can occur in a wide region since negative energy photons of sufficiently high energy do not respect Faraday cage. The reason is that there is not system able to absorb them and thus drop to a lower energy state. The net charge is developed because the negative energy topological light rays act as "bridges" along which the charge can move between space-time sheets. Since there is an electric field in the direction of the bridges, the charges move only in second direction fixed by the sign of the charge.

4. Switching on of the current acts as a control process which switches much larger process in environment using negative energy photons. Basically the process is due to the inherent instability of the many-sheeted space-time. What happens is analogous to a transition from a bottom of potential well in a fractal spin glass energy landscape to a bottom of a deeper potential well. The process leads to a gradual transfer of matter to larger space-time sheets and cooling. The generation of larger space-time sheets means evolution of consciousness since the p-adic prime characterizing the space-time sheets identifiable as a kind of intelligence quotient grows in the process.

5. In order to maximize the intensity of negative energy photons and get as dramatic effect as possible, the parameters characterizing the pulse series can be optimized. The basic idea is that the system is rapidly shaken. This generates accelerations of opposite sign and the system is decelerated and accelerated in a fast tempo. There is however a limitation coming from the fact that charge carriers must have enough time to return to rest. We use instinctively this trick when we try to wake up a person who has lost consciousness.

4.2 Do Scalar Wave Pulses Appear Also Outside Electric Circuits?

The transients at the ends of voltage pulses correspond to a constant electric field propagating as scalar wave pulses with light velocity when the inertial quantum effects caused by the coupling with matter can be neglected. TGD allows solutions of field equations describing free scalar wave pulses with longitudinal electric field. Both positive and negative energy pulses are possible. The interesting question is whether the findings of Tesla necessitate the emission of free scalar wave pulses.

1. On basis of foregoing considerations it would seem that Tesla's scalar wave pulses outside the pulsed circuits are not necessary if one wants to understand the findings of Tesla. Of course, they could be involved.

2. In the chapter "Rosetta Stone" of the book of Vassilatos [H1] there is a summary of the properties of the electro-radiative event (ERE) observed by Tesla. It seems that one could understand them as effects induced by the emission of negative energy photons.

   In particular, ERE leaves wires and other circuit elements in a direction orthogonal to them. This favors strongly the interpretation in terms of topological light rays identifiable as TGD counterparts of ordinary radiation. In TGD topological light rays are however carriers of light like vacuum(!) 4-currents so that they generate coherent photons and can also carry Bose-Einstein condensates of parallel photons. The filament like light emitting structures orthogonal to metal coils could thus correspond to topological light rays. If they carry negative energy they should also generate coherent photons with negative energies.

3. Scalar wave pulses should leave an open wire in a direction parallel to the wire. The open secondary coil of Tesla transformer is a good candidate in this respect. From a capacitor the pulses should leave in a direction orthogonal to the capacitor plate and might reduce the voltage of the capacitor by carrying quanta of electric flux which are very much like small capacitors themselves moving with a light velocity.

4.3 Why The Radiation Observed By Tesla Was So Difficult To Detect Using Photography?

In the chapter "Rosetta Stone" of his book [H1] Vassilatos tells that although the radiation emitted by the Tesla's circuits was perceived both visually and experienced as physiological effects it was very difficult to detect it instrumentally, for instance by photographing: long deposit times were required.

The explanation for this might be very simple. Body and especially retina are full of population inverted many-sheeted lasers which can amplify a weak signal of negative energy photons to a much stronger signal consisting of positive energy photons. Ordinary photographic film very probably is not able to do this.

This idea is supported also by the TGD based model for sensory receptors [K5]. In TGD Universe sensory organs are the carriers of primary qualia like color, and one can say that brain only writes the sensory music to notes. Since brain processes the sensory input in a selective manner, a back projection from brain to sensory organs making virtual sensory experiences possible must be present. Negative energy photons provide the most elegant manner to realize this mechanism since bio-matter is transparent to them unless there are many-sheeted lasers tuned to the wavelength in question.

Photo receptors indeed contain a lot of mitochondria serving as energy plants of the cell and mitochondria are known to generate visible light which is not a mere side product of metabolism [I1]. This suggests that the signal consisting of negative energy photons is amplified to a positive energy visual signal in retina. This would occur during dreaming and explain rapid eye movements. The mechanism would make it possible to see using negative energy photons and even seeing even through physical objects using phase conjugated photons as the findings of Feinberg demonstrate [D4]. A camera using negative energy photons is a possible technological application. The camera would make it possible to take images through walls.

4.4 How Tesla Transformer Manages To Yield So High Voltage Amplification?

Tesla reported that his transformers have an anomalously high voltage amplification. There are two cases to be considered corresponding to pulsed ordinary and bi-filar primary coils. In both cases it might be possible to understand Tesla's findings.

1. In the case of the ordinary coil the repeated acceleration of charges induced by electric pulses generates magnetic pulses inducing in turn voltage over the secondary coil. This is what also Maxwell's theory predicts. The emission of negative energy photons inducing the increase of conductivity and an anomalous amplification of the primary current would however mean that also the voltage induced in the secondary coil is anomalously high.

2. Only the net current flowing in the pulsed bi-filar coil induces electromotive force in the secondary coil. Thus the magnetic pulses should become much sharper than in the case of the ordinary coil. Already this implies that the induced voltage along the secondary coil, being proportional to the time derivative of the magnetic flux, is very high during the short pulse. The currents induced by the electric pulse in the bi-filar coil increase also rapidly the resonance mechanism and eventually more or less compensate each other. The increase of conductivity is a further amplification mechanism possibly involved. By using a several primary bi-filar coils arranged around circle and having suitable phase lag, one could perhaps arrange a permanent anomalously large inductive effect.

4.5 Why No Current Was Observed In The Secondaries Of Tesla Transformers?

Tesla did not detect the emission of charge carriers from the open ends of the secondary coils of his transformers. What one would expect is that the voltage along the secondary generates a flow of charge carriers which are stuck to the open end and that part of them leaks out. Two factors are involved.

1. There was no current at atomic dissipative space-time sheets if the charge carriers are dropped to larger space-time sheets: perhaps at the flux tubes of the magnetic fields generated in the process or at the magnetic flux tubes of the Earth's magnetic field or its dark counterpart [K4]. An interesting possibility is that closed magnetic super conducting circuits involving primary and secondary coils are formed. The magnetic flux tubes could carry the charges also to environment and negative energy topological light rays might help to transfer the charge to the metallic objects in the environment.

2. Electric pulses corresponds to a Tesla scalar wave pulses so that the surface charges associated with the ends of the pulse correspond to vacuum charges and vacuum currents. Therefore no ordinary charge carriers were associated with them.

5 Super-Luminal Velocities, Massless Extremals, And Quantum Jumps Between Quantum Histories

Super-luminal light velocities have been observed during the last half decade in various systems [D7]. The first evidence came from the experiments of Chiao and Steinberg [D9] and the experiment of Nimtz and collaborators [D5]. In the latter experiment Mozartz Symphony #40 was transduced using microwaves with a super-luminal velocity equal to $4.7c$. What makes this experiment especially interesting is that it challenges the assumption about c as the maximal signal velocity and Nimtz indeed believes that signal propagation with super-luminal velocities is possible. Variants of these experiments have been later repeated using microwaves and laser light and super-luminal velocities as high as $300c$ have been observed [D6]. Also evidence for two different tunnelling times [D2] corresponding to the lateral displacement and angular deflection of the beam has been found.

To my opinion, these strange effects are a genuine challenge for the theories having Lorentz invariance as a basic symmetry. In TGD framework super-luminality has a surprisingly simple phenomenological description in terms of quantum jump between quantum histories concept and massless extremals (MEs) providing a "Bohr orbit" model for the quantized gauge fields. These concepts provide also a first principle quantum description for dissipation and self-organization [K11]. MEs are in a key role in TGD based model of consciousness and living matter [K5, K9, K10]. The strange causal anomalies of neuroscience [J4, J1] and the observations of Radin and Bierman [J2] provide support for the notion. The model for the propagation with effective super-luminal velocity provides especially clean evidence for the importance of MEs and allows to build a more detailed view about MEs. Super-luminal effects also encourage to take seriously the exotic energy- and communication technologies suggested by TGD.

5.1 General Model For Super-Luminal Velocities

Consider first the general model for the super-luminal velocities in TGD framework.

5.1.1 Massless extremals as Bohr orbit representation of em field

In TGD framework self-organization occurs by quantum jumps between quantum histories. Quantum histories have as their geometric correlates classical space-time surfaces with topological field quanta represented by space-time sheets and carrying classical gauge field configurations providing "Bohr orbit" type representation for quantum fields. The "Bohr orbits" associated with photons correspond to the so called massless extremals (MEs) carrying superposition of the harmonics $f_n = nf_1$ of the fundamental frequency f_1 determined by the length L of ME ($f_1 = c/L$). The

light-like vacuum current associated with ME generates coherent photons and ME also carries a Bose-Einstein condensate of collinear photons at these frequencies. Assuming that these photons are detected, a nice understanding of the relationship between descriptions based on classical fields and photons results. What is important is that both aspects are necessary for the proper understanding of the phenomena involved.

5.1.2 The interaction of the space-time surface representing photon beam with medium breaks it into MEs

The effect involves the interaction of the photon beam with the medium idealized as a potential barrier and by a model for the dispersion boiling down to a frequency dependent di-electric constant and magnetic permeability. This interaction involves dissipation which means in TGD framework self-organization involving a sequence of quantum jumps between quantum histories. The intuitive view is that coherence is lost so that individual components of the classical em field propagate without interfering. Geometrically this means that medium induces the decomposition of the classical em field represented by single space-time sheet X^4_e associated with photon beam state to separate space-time sheets represented as MEs which are analogous to virtual photons. One can visualize the effect of the medium to the space-time surface representing the em field as a collision inducing the breaking of this surface into pieces represented by MEs analogous to virtual photons.

5.1.3 The drift of ME towards geometric past induces the increase of the effective light velocity

The classical 4-dimensional(!) field configuration associated with ME changes in each quantum jump. Depending on whether the average shift occurring in the quantum jump is forwards or backwards in time, a reduction or increase of the effective light velocity results. If MEs correspond to space-time sheets of finite geometrotemporal duration (which is not same as the duration defined by the number of quantum jumps during which ME exists), this shift of the field configuration could simply result from the drift of ME to the direction of the geometric future or past. Super-luminality would mean that the direction of the arrow of the geometric time changes locally.

The reversed time arrow means that MEs carrying negative classical energies are generated in the experiment. The negative energy MEs would drift to the direction of the geometric past and give rise to effective super-luminality whereas positive energy MEs would drift to the direction of the geometric future and induce the effective reduction of the light velocity observed in the normal situation. Only effective sub-/super-luminality is in question since light velocity is c for each ME in the sequence. In TGD inspired theory of consciousness this mechanism is fundamental for the understanding of EEG: the velocity $v \sim 10$ m/s identified usually as phase velocity of EEG waves correspond to the drift velocity of ELF MEs in TGD framework [K9].

Rather paradoxically, it is possible to have a situation in which after sufficiently many quantum jumps the classical field leaves the medium before it entered it in the space-time surface associated with the first quantum jump. Note however that for the space-time surface associated with the last quantum jump classical signal entered the medium before it left it.

Doppler shift provides a test distinguishing between genuine super-luminality and effective super-luminality and perhaps also between TGD view and standard dispersion model based on the assumption that propagation velocity in medium depends on frequency. The prediction is that c rather than $v > c$ should appear in the formula of the Doppler shift.

5.1.4 Interference of photon beams described in terms of MEs

The basic question is how should one describe in TGD framework the combination of beams to form single beam giving rise to interference effects? To answer this question one must keep in mind the basic philosophy: it is classical gauge fields associated with MEs which provide the fundamental description of the phenomenon and photons provide only a diagnostic tool allowing to measure the strengths of the classical fields associated with MEs.

The fusion of photon beams is the reverse of the process causing de-coherence and thus describable as a fusion of MEs to the space-time sheet X^4_e representing the em field outside medium. Positive/negative energy ME is a geometrical analog of a virtual particle emitted by X^4_e and travelling forwards/backwards in time to be eventually absorbed.

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Concerning the precise geometric meaning of the fusion there one can consider two options:

1. Fusion corresponds to the formation of topological sum in which case ME and X^4_e are parallel space-time sheets having distance of order CP_2 size. The interference of the classical gauge fields is not possible in this case since they reside on different space-time sheets.

2. Fusion corresponds to the formation of join along boundaries bonds/flux tubes between boundaries of ME and X^4_e. The classical fields associated with ME interfere with those associated with X^4_e when they enter into X^4_e. Hence this option is strongly favored.

In case 2) the resulting structure is a 4-dimensional variant of a typical string diagram with each ME representing a loop carrying photons with basic frequency and its harmonics. These loops also interact with the medium and interaction is also induced by the formation of flux tubes. In each quantum jump the positive/negative energy virtual ME shifts forwards/backwards in geometric time: this is very much like motion of MEs along the 3-dimensional boundary of X^4_e. In normal dispersive media positive energy MEs leading to the reduction of the light velocity dominate.

This rather surreal picture suggests that virtual MEs are like living creatures creeping along the boundary of X^4_e to the direction of past or future: this brings in mind proteins creeping in a similar manner along microtubular surface. In fact, MEs are identified as carriers of life forms in TGD inspired theory of living systems [K5]: the reason is that they carry so called exotic p-adic Super Virasoro representations providing MEs with enormous information storage and representation capacities.

5.1.5 Do the photons associated with negative energy MEs have positive or negative energies?

Classical-quantum correspondence suggests strongly that the photons generated by the negative energy MEs have negative energies. It is quite possible that negative energy photons could be regarded as counterparts of negative energy on mass shell photons appearing in the Hamiltonian formalism and assigned with annihilation operators. On space-time sheets with negative time orientation they do not annihilate vacuum and generate genuine many particle states. These on mass shell states have however finite spatiotemporal extend. When the plane wave restricted to a finite space-time volume is developed into Fourier series in entire Minkowski space, the series contains also off mass shell components: this suggests an obvious connection with the virtual particle concept used in Feynman diagrammatics.

If negative energy photons are generated, the absorption of these photons on the positive energy space-time sheets could result as transitions of the excited states of atoms to ground state without photon emission and would be analogous to higher order processes induced by the exchange of negative energy virtual photons. In the similar manner emission of negative energy photons would lead from ground state to an excited state. The creation of pairs MEs with opposite time orientations, and thus also classical energies, accompanied by positive/negative energy photons provides mechanisms of amplification and population inversion. Population inversion can occur through the emission of negative energy photons whereas as amplification involves emission of positive energy photons in a state with an inverted population. Amplification/generation of population inversion presumably involves BE condensation of positive/negative energy photons on positive/negative energy MEs and a generation of positive/negative energy BE condensate.

Since the transmission time is measured by interference effects, it is basically classical field which is measured by the rate of photons it produces. More concretely and using standard terminology, the incoming photon beam is split to a part going through the optical barrier and a part which travels in the free space, and these beams are combined together in such a position that destructive or constructive interference occurs [D7]. Hence the experimental arrangements used do not provide answer to the question whether negative energy photons are present or not.

Rather interestingly, the experimental arrangement yielding super-luminal velocity of 300c [D6] is a slight modification of an arrangement yielding amplification. In a normal situation first beam

generates population inversion and second beam with a precisely defined wavelength is amplified. In the super-luminal situation the wavelength of the second beam differs slightly from the value yielding amplification and only super-luminality results.

The following interpretation of the results might make sense.

1. In the situation giving rise to amplification the transitions to ground state generate photons which suffer Bose-Einstein condensation to the ME representing second beam.

2. In the super-luminal situation population reversal seems to be amplified by a mechanism generating Bose-Einstein condensate of negative energy photons emitted in the transitions from the ground state to the excited state.

3. A recoil effect, which is slightly different for the atomic transition and its reversal due to the different rest masses of the atom in the ground state and excited states, explains why the super-luminality occurs for a slightly different photon wavelength than amplification. The rest mass of the atom is given by $Mc^2 - E_i$, where E_i, $i = 1, 2$ is the binding energy of atom in ground state and excited state. A little calculation using energy and momentum conservation for the emission of positive/negative energy photon shows that the fractional difference of photon wavelengths is is in a good approximation

$$\frac{\Delta\lambda}{\lambda} = -\frac{\Delta E}{E} \quad = \quad \frac{1}{2}(\frac{E}{Mc^2})^2 \quad . \tag{5.1}$$

If this interpretation is correct, then the only conclusion seems to be that beam amplification represents a laboratory realization of the TGD based exotic mechanism of energy production.

5.2 Quantitative Model

In the following the hypothesis that super-luminality is associated with a tunnelling through an optical barrier [D7] is criticized, a very brief summary of the basic tunnelling time models is given, and TGD based model of super-luminality based on the hypothesis that self-organization is involved.

5.2.1 Is super-luminality really associated with optical tunnelling?

In standard quantum mechanics the transmission of photons in the experimental situations involving super-luminality is modelled as a tunnelling through optical barrier and tunnelling time is in the role of the basic parameter. This approach is however plagued by several difficulties basically due to the highly phenomenological description of the dissipative effects.

1. Dispersive medium allows a handful of different velocities corresponding to phase -, group -, energy-, signal- and front velocities. The problem is to decide which of these velocities, if any, corresponds to the velocity of photon. In TGD framework this problem does not appear since the description relies solely on the classical fields associated with MEs.

2. The treatment of the situation as tunnelling can be questioned if self-organization is involved since tunnelling is essentially an effect associated with single solution of Schrödinger equation. In TGD approach the phenomenon is not treated as tunnelling but as self-organization phenomenon.

Depending on the identification of the velocity of photon, several theories for the tunnelling time result [D3].

1. In Wigner's theory [D3] group velocity is identified as the photon velocity and several experiments support the view that effective group velocity determines the transmission time [D7]. What one calculates is the time for the peak of a wave packet to emerge from the exit face of the tunnel barrier relative to the time the peak of the induced wave packet arrives at the entrance face. TGD view is consistent with this identification as long as one can assume that the phenomenological description of self-organization by quantum jumps using classical field equations with complex dielectric constant is a good approximation.

2. Buttiker-Landauer time is based on semiclassical model [D3]. Since the phenomenon is modelled as a tunnelling phenomenon, wave vector and velocity are purely imaginary inside the medium so that one must use absolute value. To my opinion, this feature makes this approach highly questionable although it seems obvious to me that the emergence of the imaginary time signals for the presence of two times: the geometric time and the subjectively experienced time defined by the sequence of quantum jumps in TGD.

5.2.2 Model for the drift of ME in time direction

Consider now a simple TGD based model for the reduction/increase of the effective light velocity and estimation of the effective light velocity.

1. In single quantum jump the average increase of psychological time defined as the center of mass temporal coordinate for the cognitive space-time sheet representing conscious observer is assumed to be given by

$$\tau = \tau_{CP_2} \simeq 10^{-39} \ \ sec \ .$$

The phrase "cognitive space-time sheet" sounds strange in present context but means only that space-time sheet has finite geometro-temporal duration. This hypothesis applies to quantum jumps of any self-organizing system in particular MEs, which are basic building blocks of living matter in TGD inspired theory of consciousness. The estimate for τ relies on dimensional analysis and is assumed to hold true for space-time sheets which have suffered topological condensation to the interior of a larger space-time sheet by topological sum contacts. This however is not the case now since MEs suffer 3-dimensional topological condensation on the boundary of X^4_e representing em field outside the medium (the formation of join along boundaries bonds is nothing but topological condensation for boundaries).

2. If ME is glued by flux tubes to the boundary of X^4_e, the average increment of geometric time in quantum jump, call it τ_B, is not necessarily equal τ and one has

$$\tau_B \ = \ p\tau \ . \tag{5.2}$$

Here p represents a numerical factor depending on the properties of the cognitive space-time sheet and on the properties of the boundary of X^4_e. Unless n is constant, cognitive space-time sheets drift along the 3-dimensional boundary of X^4_e with different velocities. Situation can be also complicated by the fact that ME need not be all the time in the self-organizing self-state and it could be that the drifting does not occur otherwise: this obviously implies the variation of the effective values of τ_B and p.

Consider now how the reduction/increase of the effective light velocity results in this picture.

1. Suppose that the classical field configuration is shifted in time direction by average time interval

$$\Delta t = p\tau \ .$$

in single quantum jump. For $p > 0$ ($p < 0$) the shift is to the direction of the geometric future (past). If ME shifts as such without any change in the field configuration and is all the time in the self-organizing state, then $p = 1$ corresponds to the simplest situation in which all cognitive space-time sheets drift with the same velocity to the direction of future. During the self-organization process initiated at time t_0 and having lasted for a time $T = t - t_0$, the net temporal shift of the field configuration, is

$$\Delta T \ = \ pT = p(t - t_0) \ . \tag{5.3}$$

The resulting temporal shift of the field configuration $\Psi(x,t)$ is

$$\Psi(x,t) \to \Psi(x,t-\Delta T) = \Psi(x,t-p(t-t_0)) \ .$$

2. In particular, the effectively 2-dimensional field configuration

$$\Psi(x-ct)$$

associated with ME and propagating with light velocity, is replaced with the field configuration

$$\Psi(x-c(t-pT)) \quad = \quad \Psi(x-c(1-p)t+pct_0) \ . \tag{5.4}$$

The effective propagation velocity is thus

$$v \quad = \quad c(1-p) \ , \tag{5.5}$$

and is indeed super-luminal for $p < 0$. Also phase shift determined by the parameter pct_0 occurs.

5.2.3 Relationship of the effective light velocity with the parameters describing dispersive media

Experimental data as well as the fact that classical fields associated with MEs provide a basic description of the process, encourage the identification of the effective light velocity v as group velocity

$$v \quad = \quad c_g = \frac{d\omega}{dk} \ . \tag{5.6}$$

From the relationships

$$\omega(k) = kc_1 \ , \quad c_1 = Kc \ , \quad K = \sqrt{\frac{\epsilon_0\mu_0}{\epsilon(\omega)\mu(\omega)}} \ , \tag{5.7}$$

one has

$$\begin{aligned} v &= c_1 + \omega\frac{dc_1}{d\omega} \ , \\ 1+p &= K + \omega\frac{dK}{d\omega} \ . \end{aligned} \tag{5.8}$$

Thus one can relate the parameter p to the parameters ϵ and μ characterizing the dispersive medium phenomenologically.

The fact that several super-luminal velocities are observed [D7], means that the negative energy MEs generated in the experiment drift with widely different different average velocities to the geometric past. The possibility of several drift velocities could relate to the fact that the dispersion relation $\omega = kc_1(\omega)$ allows several solutions for a given wave vector. Since also sub-luminal effective transmission velocities depend on frequency, also the positive energy MEs having different lengths and therefore different fundamental frequencies drift with different average velocities to the direction of geometric future. The appearance of several super-luminal light velocities suggests that there are several simultaneous self-organization processes and that the value of p depends on the asymptotic pattern of the self-organization process.

The observation of several super-luminal velocities is consistent with the assumption that the temporal drift rate along the boundaries of X^4_e, as opposed to the drift rate along the interior of

X_e^4, is not constant and can vary by at least two orders of magnitude. An alternative possibility is that MEs spend only part of time in quantum self-organizing "self-state" (being thus p-adically unentangled) in which they drift. The possibility of velocities as high as $v = 300c$ [D6] would mean that for lower super-luminal velocities, say $v = 1.8c$, ME drifts along boundary for less than one percent of time.

5.3 Possible Technological Implications

The significance of the super-luminal velocities is that they provide empirical support for those predictions of quantum TGD, which are in deepest conflict with the standard physics views and predict the possibility of new, rather science fictive technologies.

1. The mere assumption that space-time is many-sheeted 4-surface, implies the possibility of negative time orientations and negative energies. This suggests the possibility of generating energy from vacuum by simply generating pairs of space-time sheets with opposite energies. For instance, the generation of MEs with opposite momenta could be in a fundamental role in biology and make possible coherent motion. MEs carry also so called exotic representations of Super Virasoro algebra giving rise to exotic ultra light particles and these particles are in a key role in TGD based model of life.

2. The possibility of classical communications backwards in time are suggested strongly and would be realized by MEs with negative time orientation. Quantum communications forwards/backwards in time would correspond to the drift of positive/negative energy MEs forwards/backwards in geometric time and the explanation of super-luminality involves this assumption. These communications are nothing but conscious life moving forwards/backwards in geometric time (perhaps one could speak of life and anti-life!). the basic difference between classical and quantum communications would be that message is replaced by a conscious messenger in quantum communications. Combination of the communications into geometric past and future would make possible apparent super-luminal communications. Incredible as it sounds, also communications with the civilizations of the geometric past and future become in principle possible.

The explanation of both the ordinary reduction of the effective propagation velocity of light and super-luminality in terms of MEs, together with the explanation of the amplification mechanism associated with the experimental arrangement used by Wang, means that these experiments provide clear empirical evidence for the generation of MEs (as well as photons) with both negative and opposite energies having finite time duration and drifting quantum jump by quantum jump into geometric future or past. These properties are indeed crucial for the prerequisites of new energy and information technologies.

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6 Figures And Illustrations

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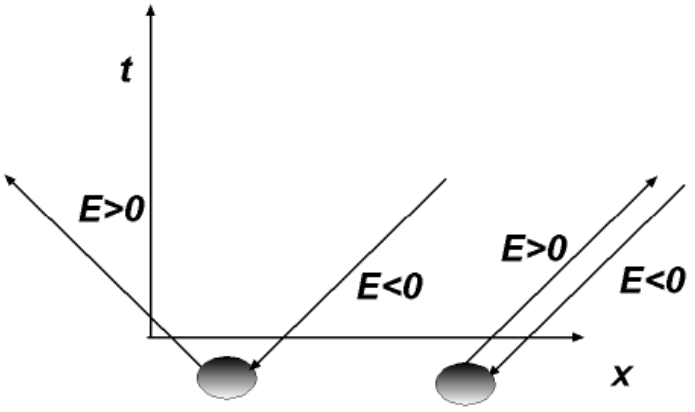

Figure 1: Time mirror mechanism

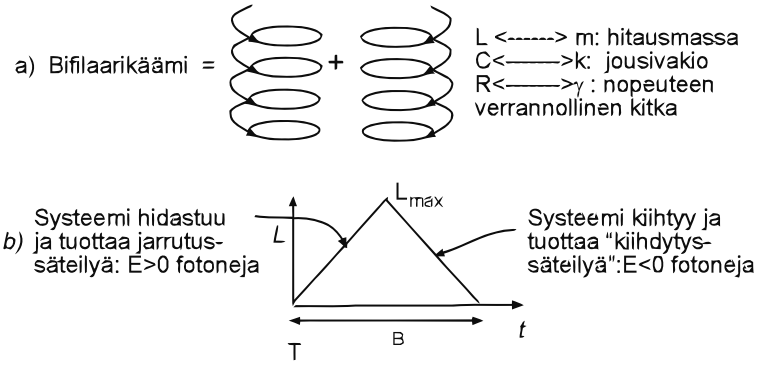

Figure 2: a) The structure of bi-filar coils and the mechanical analog of RCL circuit as a harmonic oscillator. b) The reduction of the mass of the harmonic oscillator at the second half of the magnetic pulse implies acceleration and generation of negative energy photons in order to get energy.

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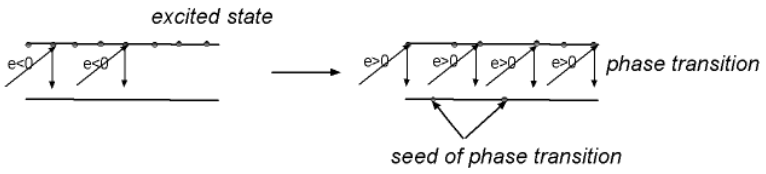

Figure 3: A mechanism of energy production based on negative energy topological light rays and population inversion.

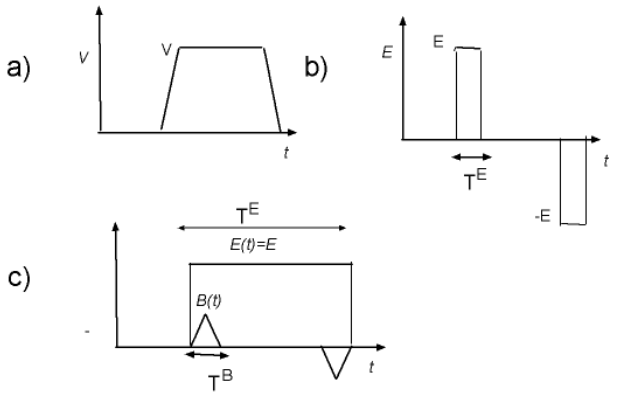

Figure 4: Constant voltage pulse (a) and the corresponding electric (b) and magnetic (c) pulses in the bi-filar coil.

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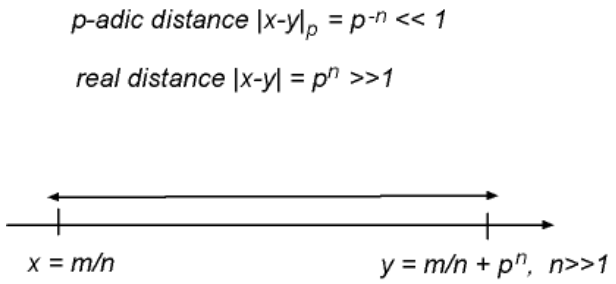

Figure 5: Rational valued points x and $y = x + p^n$, which are close to each other p-adically, are far from each other in real sense.

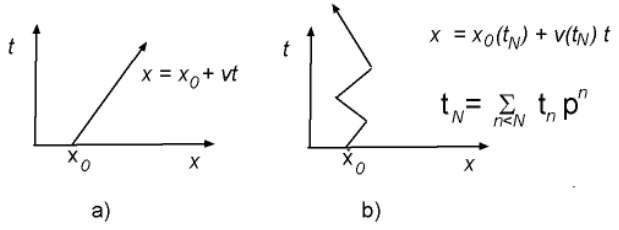

Figure 6: The non-determinism of p-adic differential equations in the case of a free particle. a) In real case the initial position $x_0$andvelocity v determine the orbit. b) In the p-adic case x_0 and v are piecewise constant functions of time and the orbit resembles that associated with Brown motion.

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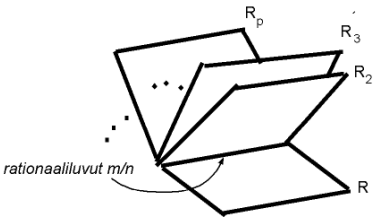

Figure 7: Rational numbers are common to both reals R and all p-adic number fields R_p, $p = 2, 3, ...$ These number fields can be "glued" together along the rational numbers to form a book like structure. Rational numbers correspond to the rim of the book and different number fields to its pages.

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