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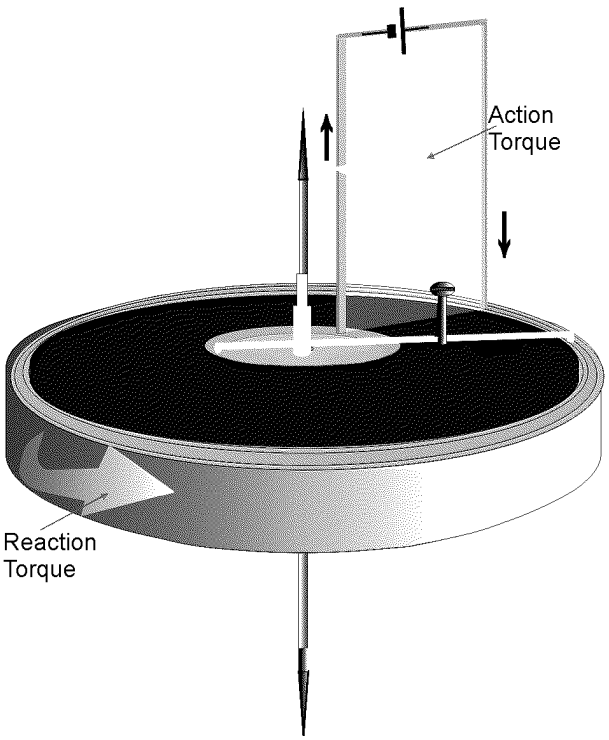
Spacetime & Substance

International Physical Journal



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THE CREATION OF TIME FROM SUBSTANCE AND SPACE

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The 'problem of time' can be 'solved' by observing that 'time' is a computational artifact originating from the 'change' in the states and configurations of substance (matter) at all scales and levels of complexity in the space of an evolving Universe. 'Change' results from instabilities in the configurations of matter, which are driven by the fundamental forces into more stable configurations. The reconfiguration processes resulting in the hierarchical forms of matter throughout the universe are the fundamental sources of 'signals', which carry 'information' from one material system to another. The process of pairing signals, from one changing system (a standard clock) to 'observed' signals from another changing system, creates 'time labeled' information states or 'infostates'. The difference between the time labels for any two infostates is defined as the 'time' elapsed between the two observed events. 'Time' does not exist a priori, but is in fact a computed measure of change. The 'logic' involved in producing time labeled infostates is illustrated using a 'T-computer' model. The construction of a 'direction' and 'dimension' for 'arrows of time' follows from the 'time differences' between labels for the time labeled 'infostates'. The set of all time labeled infostates forms the basis for conventional 'time' coordinates.

1. Is There a 'Problem of Time'?

"Why is the flow of psychological time identical with the direction of increasing entropy? The answer is simple: Man is part of nature, and his memory is a registering instrument subject to the laws of information theory. The increase of information defines the direction of subjective time. Yesterday's experiences are registered in our memory, those of tomorrow are not, and they cannot be registered before tomorrow has become today. The time of our experience is the time which manifests itself through a registering instrument. It is not a human prerogative to define a flow of time; every registering instrument does the same. What we call the time direction, the direction of becoming, is a relation between a registering instrument and its environment; and the statistical isotropy of the universe guarantees that this relation is the same for all such instruments, including human memory." — Han Reichenbach [1].

What is time? Time is a form of *information* [2] that represents a *measure* of *change* [3]. If nothing *changes*, then 'time' has no meaning. 'Change' in the shape, contents, energies, and other physical and chemical properties of substances (matter) forming systems spread throughout the universe is observed as signals originating in or modified by the reconfigurations of these islands on the sea of the vacuum. The reconfigurations are driven by the fundamental interactions of matter with other matter or with the vacuum (space). The problem of time is how do we construct 'time' from change in the universe?

The 'problem of time' can be 'solved' by showing that 'time' is a computational artifact originating from the 'change' in the states and configurations of substance (matter) at all scales and levels of complexity in the space from particles to the galaxy distributions mapping the large scale structure and texture of the evolving Universe [2]. The solution includes a general method of computing time that can apply to the common housefly evading a predator as well as humans attempting to evade the aging process. The T-computer is a general model for physical systems that can take information from signals coming from an observed object in the environment and give them a time label relative to an internal or standard clock. In the simple case of the fly, images are processed and time labeled with respect to the fly's heart rate. They are compared to previously stored (even if only in 'volatile' or temporary memory) images in order to determine an evasive flight path in the fly's 'future'.

This kind of time is relative, non-quantitative and relies on the ordering of the detected signals in a memory. The ordering process creates a kind of time labeling without the need for the normal numbers we associate with the time we read off clocks. The fly needs a primitive sense of time in order to extrapolate the most probable pursuit curve of it prey in order to evade it and survive. Any system that can store information in sequentially ordered sets and compare their relative position with respect to an internal or external standard clock can create 'time' as a measure of what has changed and what might change. The 'problem of

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time' can be transformed into a problem of the creation of time by processing the information we gather about the things that change around us and in us.

In this paper I will briefly outline a general model for the creation of *time* from *change*. This may help to explain what *time is*, but it still leaves the question open about the deep nature and origin of 'change'. The 'problem of time' can be solved but it leaves behind a 'problem of change'.

2. Unstable Systems, Change, and Clocks

'Change' results from instabilities in the configurations of matter. These unstable systems or 'clocks' are driven into more stable configurations by the fundamental forces (i.e. strong, electromagnetic, weak and gravitational). If the clock is a quantum system then it is a '**Feynman clock**' or **FC** [2] named after the method of Feynman diagrams. The reconfiguration processes produce the hierarchical forms of matter throughout the universe. During the reconfiguration process signals can be produced. These signals propagate through space carrying 'information' from one material system to another. A clock in this framework is any system that produces or modifies information (signals) during internal processes or through interactive processes with other systems or signals.

3. Signal Detection and Time Labeling

The process of pairing signals, one from a reference system (e.g. a standard clock) and one from an 'observed' system, creates 'time labeled' information states or 'infostates' combining information from both systems. This new infostates is stored in the memory of the observer's information processing system. This computational process in a physical system is a form of time-computer or '*T-computer*'. This is illustrated with a general 'T-computer' model or T-machine (see Figure 1).

The progression of information transfer through the T-computer is mapped by the position of the infostate representing the coupling of the original coincident signals and subsequent 'processed' or computed infostates as they are operated on by sequential 'gates' in the network. This information propagates through the T-computer from the Feynman and Standard clock sources to a time labeled memory. The final calculation of the 'time difference', $\Delta t = t_2 - t_1$, between any two observed events or infostates stored in two different memory locations requires physical 'logic' that can find the 'difference' between the time labels associated with the stored event information. In the following equations the nth composite state, S_n, is listed for the entire T-computer acting as a single quantum system (Figure 1). This state represents a given configuration for the entire system focusing on the 'active' infostate in the causal network. In the following, $|Network_n\rangle = |N_n\rangle$, refers to the 'inactive' collective state of the network components not involved with the location of the 'active' infostate.

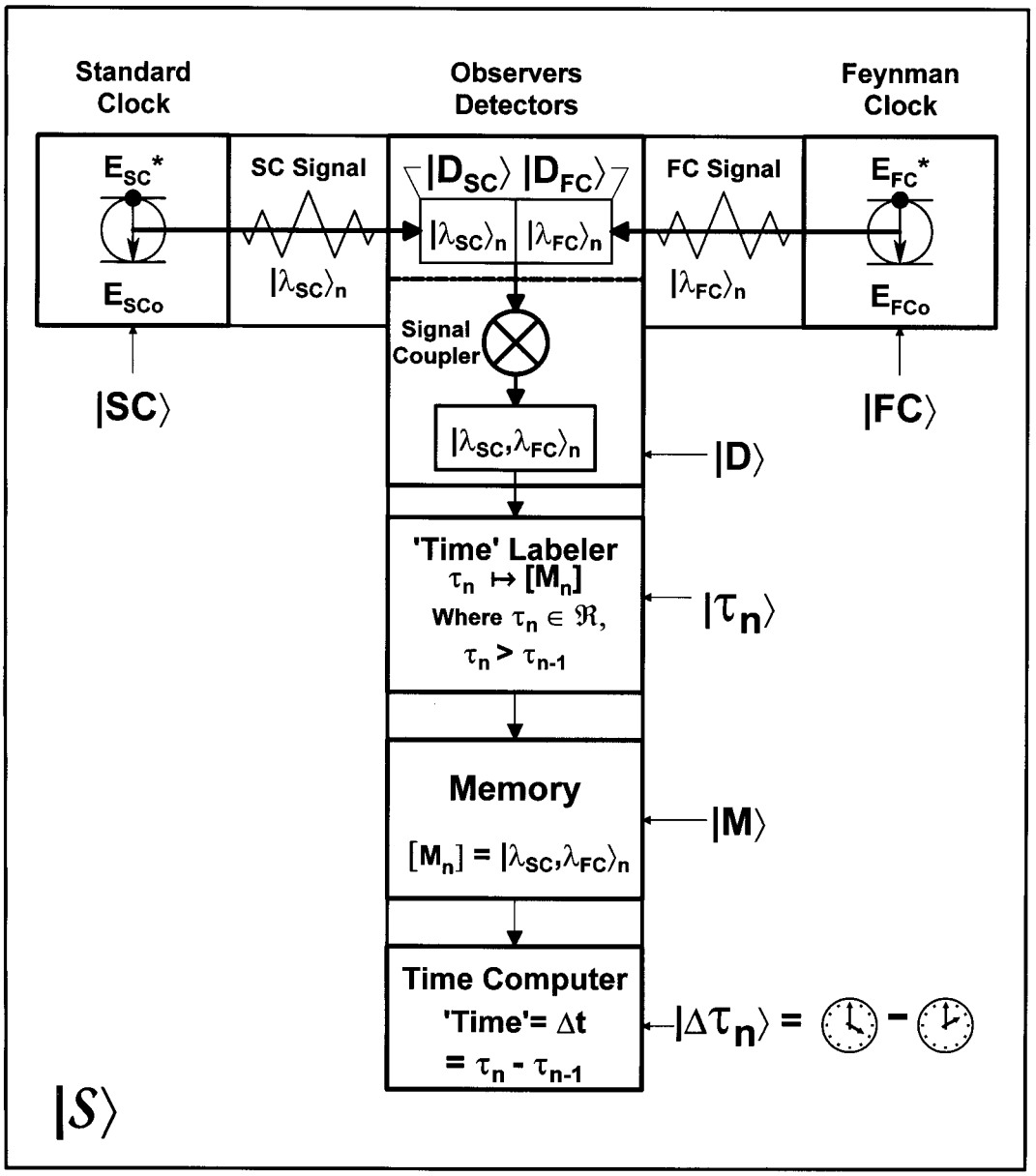
The sequence of information flow through a causal network (e.g. T-computer) is tracked by 'active' or 'excited' (e.g. $|FC*\rangle$ infostate representing the spatial location in the network of all the relevant information corresponding to the observed event. The non-active states of the remaining components in the network are summed in the Network0ñ term. The nth (computational) state of the entire T-computer system is S_n. This corresponds to the infostate at a physical gate location in the causal network.

We will assume that the initial configuration of the composite system is given by $|S_n\rangle = |S_0\rangle$, for $n = 0$. The standard clock and the 'observed' system provide the information (signals) to the T-computer detectors through open space or by closed 'circuits' or 'guides'.

We want to remember that we implicitly use another distinct T-computer when we assign a 'start time' for the flow of information through any causal network or T-computer. Since the point here is that 'time' is a bit or qubit of information generated by the T-computer, the start and stop times can be ignored. We will also ignore any 'decoherence' effects on the infostate through its' interaction with the environment (e.g. vacuum) since the decay 'lifetime' of a system due to this coupling is already included in the system start and stop signals processed by the observer. The network will be considered to be robust enough to withstand decay of the local infostate in the active gate or node in the network.

The equations below are intended to illustrate the general features of the T-computer. The details of the physical 'logic' gates and nodes forming a T-computer and the appropriate equations describing them are currently being investigated by the author and will be published at a later date.

We assume that we have an initial configuration of the entire quantum system involving the signal sources, however extended or remote in space, and the causal network forming the T-computer given by the superposition (sum) of all the infostates of the components in the extended system. These are represented by the collective state of the system, S_0, defining a reference 'start' state of the T-computer where the state index is $n = 0$. The following equations represent the state of the entire system in which the 'active' signals, nodes or gates are identified separately from the remainder of the 'inactive' components of the network. This allows us to see how the 'infostate' is created and propagates through the network. We can see how it changes ('expands' with additional qubits into larger qwords or is



'T' Computer

Figure 1: The schematic diagram of a simple idealized T-computer. The functions of the logic 'gates' or nodes and the signals flowing between them represent a general model of the computation of 'time differences' between events in a 'time-independent' information space of 'infostates', $I(S)$, and the system or causal network forming the time labeling computer is in state $|S\rangle$. This state is the collective 'infostate' of the entire network forming the T-computer including the active and inactive components of the relevant computational network. The intent of modeling a T-computer is to show two things. First is that 'time' is a computational artifact of a signal mapping process that defines time as function of the coincidence a clock signal with an event signal. Second is that the T-computer is a component or sub-network of more complex information processing systems. The T-computer is essentially a quantum computer with classical 'time' as an output. The principles in the signal mapping process also apply for larger scale systems that can be treated by classical methods. The key is that all the information used to define time at the macroscopic scale is traceable backwards to the origin of information in the microscopic 'quantum' world.

'reduced' to the selected information needed for a time computation) as it is acted upon by the 'logic' of the network.

The active components (e.g. signals, 'nodes' or 'gates') of the T-computer system (i.e. the 'current' location of relevant information from the 'observed and time labeled' expanded infostate including additional qubits form any extra information created by processing or logic activities on the incoming infostate) and the remainder 'inactive' network for the start state is given by states in Dirac notation.

We begin with the initial state of the T-computer:

$$|FC^*\rangle + |D\rangle + |SC^*\rangle + |N_0\rangle \,. \tag{1}$$

The active (excited) states of the FC and SC are direct product states of their respective 'ground' states and the 'potential' outgoing signal. They are initially entangled until full decay at which point they become a 'distinct' linear superposition of quantum systems. When the source and its signal become 'measurably distinct' we can consider them to be 'classically' separated. This 'separation' is represented as a sum (+) rather than the direct product ($\otimes$).

The causal network forming the T-computer is a 'quantum' system. 'Classical properties' of a network are the result of mesoscopic or macroscopic collective excitations or behaviors resulting from the composite collective interactions of the quantum sub-systems or sub-networks. The distinction between quantum and classical scale phenomena is mainly a matter of the observers' choice of what is to be observed. For example, one could measure the 'classical' temperature of a gas cell (a 'thermodynamic' infostate) or the optical scattering of individual 'quantum' photons by the particles in that same gas cell (quantum causal network infostates). The total system is neither quantum or classical alone, but a system with both quantum and classical infostates at various hierarchical levels of complexity.

We note that the Dirac notation lends itself to an oversimplified 'compact' representation of the state of a system considered to have a distinct quantum identity. We neglect the interactions of components of the system with each other or the environment if they are not 'active'. 'Active' components are defined by the 'attention' interaction of the observer with the T-computer. This interaction is the result of an ongoing coupling or feedback between the information source, a standard clock and the observer.

The superposition of the quantum states or the quantum components of an ensemble system represents a system that does not support or generate collective excitations as the result of a 'condensate' state. The condensate state of an n-body system that generates or supports collective excitations is the result of the coupling of all the components in such a way that they are more than a superposition. The expression of this collective or entangled condensate is the direct product of the system states whose whole is clearly more that the sum (superposition) of the parts.

$$[|FC^*\rangle \to |FC_0\rangle \otimes |\lambda_{FC}\rangle] + |D\rangle$$
$$+ [|SC^*\rangle \to |SC_0\rangle \otimes |\lambda_{SC}\rangle] + |N_1\rangle \,.$$

The decay rates of the FC and the SC may be different. We will assume that the detector will 'hold' the FC infostate until the next available signal arrives from the standard clock. When both signals are detected they are converted into a 2-qubit infostate.

$$[|FC_0\rangle \otimes |\lambda_{FC}\rangle \to |FC_0\rangle + |\lambda_{FC}\rangle]$$
$$+ |D\rangle + [|SC_0\rangle \otimes |\lambda_{SC}\rangle \to |SC_0\rangle + |\lambda_{SC}\rangle] + |N_2\rangle \,.$$

The collective state of the total system is one in which the 'signals' are in transit to the detector while the rest of the network is in its 'ground' or signal detection 'ready' configuration. Once the 'classical' or spatially distinct signals become close enough to their targets to become superimposed and then entangled with the detectors, their identity as quantum signals traveling 'classically' through space is destroyed. They are now coupled to the detectors as indicated by the direct product of the infostates of the active front-end components of the T-computer.

The 'inactive' components of the network including the FC source and the SC 'time pulse generator' are lumped into the superimposed subset of the systems causal network as represent in the last term below. The 2-channel detector is now in a collective excitation state in which two q-words (or qubits) are stored in parallel quantum registers.

$$[|D\rangle + |\lambda_{FC}\rangle + |\lambda_{SC}\rangle \to |D\rangle \otimes |\lambda_{FC}\rangle \otimes |\lambda_{SC}\rangle]$$
$$+ [|FC_0\rangle + |SC_0\rangle + |N_2\rangle \to |N_3\rangle]$$
$$= |D\rangle \otimes |\lambda_{FC}\rangle \otimes |\lambda_{SC}\rangle + |N_3\rangle \,.$$

The composite infostate of the detector is an expanded 'q-word' with two q-words concatenated into a larger q-sentence. The q-sentence infostate can now be propagated along the network for used as a 'time stamp' for the 'event' originating in the FC and labeled by the SC.

$$|D\rangle \otimes |\lambda_{FC}\rangle \otimes |\lambda_{SC}\rangle$$
$$+ |N_3\rangle \to |D^*\rangle + |N_{3\to 4}\rangle = |D^*\rangle + |N_4\rangle \,.$$

The detector infostate is now given a 'label' that will be used later to compute the 'elapsed time' between events in memory or the coordinate 'time' used in standard space-time.

$$|D^*\rangle \otimes |\tau_n\rangle + |N_4\rangle \to |M_k\,, t_k\rangle$$

$$+ |D\rangle + |N_4\rangle \rightarrow |M_k\,, t_k\rangle + |D\rangle + |N_{4\rightarrow 5}\rangle$$

$$= |M_k\,, t_k\rangle + |D\rangle + |N_5\rangle\,.$$

At this point a signal from another memory location carrying the 'time label' information is shifted into the comparator.

$$[|M_{k+m}\,, t_{k+m}\rangle + |M_k\,, t_k\rangle] + |N_6\rangle\,. \tag{2}$$

The 'time labels' are qubits in the n-bit word representing the infostates for the processed information from the source and standard clock 'events' stored in the various addressable memory locations.

$$[|M_{k+m}\,, t_{k+m}\rangle \otimes |M_k\,, t_k\rangle]$$

$$+ |N_6\rangle \rightarrow |M_{k+m}\,, t_{k+m}\,, M_k\,, t_k\rangle + |N_7\rangle\,.$$

The interaction of the infostates from the two memory locations takes place in a logic gate that compares the 'time' qubits via a 'subtraction' operation. This follows from the same kind of logic used in conventional computers that address specific bits needed for a logic operation involved with finding time differences for time labeled events.

$$|M_{k+m}\,, t_{k+m}\,, M_k\,, t_k\rangle$$

$$+ |N_7\rangle \rightarrow |M_{k+m}\,, M_k\,, (t_{k+m}\,, t_k)\rangle + |N_7\rangle \rightarrow$$

$$|M_{k+m}\,, M_k\rangle \otimes |t_{k+m}\,, t_k\rangle$$

$$+ |N_{7\rightarrow 8}\rangle \rightarrow |M_{k+m}\,, M_k\rangle \otimes |\Delta t_n\rangle + |N_8\rangle\,.$$

The processing of the time labels for infostates corresponding to two events results in a 'time' infostate whose information 'content' is the difference between the labels. We are assuming that real numbers are used here, but complex numbers or any other set of number-like labels may work as long as the physical states of the register in which the computed 'time' can be translated into other higher order languages that 'interpret' causal relationships between events.

$$[|M_{k+m}\,, M_k\rangle \otimes |\Delta t_n\rangle] + |N_8\rangle \rightarrow |\Delta t_n\rangle$$

$$+ [|M_{k+m}\,, M_k\rangle + |N_8\rangle] \rightarrow |\Delta t_n\rangle + |N_9\rangle\,.$$

The information encoded in the difference between two time labels for two events is extracted by logic that can evaluate the absolute value of the difference between the two event 'times' resulting typically in a real number. These time label numbers may be physical states such as the number and polarity of charges, analog voltages, discrete binary sets of voltages, polarization states, or spin states. The numerical difference between two time labels corresponds to the physical difference between their physical states in the tubit location of the infostate qword. The physical comparison of two states by the logic of the gate in the T-computer results in the following creation of another physical state in a register that can be translated into a number by higher order information processing:

$$|\Delta t_n\rangle + |N_9\rangle \rightarrow [T[|\Delta t_n\rangle] = \Delta t_n = t_{classical}] + |N_{10}\rangle\,.$$

Where 'I' is the computers 'time infostate' resulting from the computation of the time label differences in two event infostates by the time operator, T, acting on the two-qubit infostate, $|\Delta t_n\rangle$, extracted from two memory locations. The action on this state results in conventional time, $T[|\Delta t_n\rangle] = \Delta t_n$. This is the time difference 'magnitude' between events stored in memories (k) and $(k+m)$ with respect to a standard clock.

The **constructed** *equation of time representing the* **bridge** *between quantum and classical processes is:*

$$T[|\Delta t_n\rangle] = \Delta t_n = t_{classical}. \tag{3}$$

'Time' differences and the information defining the order of infostates representing the observed events can be used to create temporal pointers or 'arrows of time' between 'earlier' and 'later' infostates (i.e. (k) and $(k+m)$ respectively). This is the 'output' of the T-computer.

The magnitude of the differences in the time labels along with the 'pointer' are used to construct arrows of time and the 'dimension' and 'direction' of the time axis in standard $(3+1)$ space-time. This is the 'classical' time that is generally used as the time 'variable' in standard physics equations of motion.

The real number time differences coupled with the loading of info-states in memory locations, M_{k+m} and M_k along with the set of all ordered events defines for the observer a 'timeline', time 'direction' and time 'dimension' (usually = '1') coupled to a standard 3-space resulting in a $(3+1)$ space-time. It also defines a Quantum Arrow of Time (QAT) for signal creation and induced infostates in detectors originating in the irreversible reconfiguration of unstable 'excited' states. 'Classical Arrows of Time' or CATs are built on collective or generalized information flow in composite quantum systems acting with behaviors that can be described by classical equations of physics and pointing from unstable system configurations to more stable ones.

Quantum information encoded as qubits and qwords are the 'contents of 'infostates' resident in gates, registers and memories. Collections of memories can support many qwords as single information objects. They may be extended quantum objects with serial (sequential excitation network or SEN) properties or collective properties (collective excitation networks or CENs). Combinations of qwords acting like a single quantum object can form qsentences. These various information structures are physical 'infostates' of the signals

or gates in which they reside. The transfer of physical objects combined with their information content defines causal networks and T-computers. The information flow in the universe occurs without any explicit dependence on time as a 'dimension'. Real and complex numbers, or any ordered set of objects can be used to 'time label' events. Unusual units of time can also be created to represent causal relationships in theoretical physics models where complex processes involve 'mixing' of spatio-temporal information as long as their 'ordering' is understood.

Recognition that 'time' is created by complex systems capable of 'computing' it, may clear up 'time' related paradoxes and issues related to causality, information theory, and the 'experience' of time inside complex states of 'consciousness'.

4. Universal Time

Let us now look at a general approach to incorporating time into the space-time constructions used in physical theories to model the evolution of the substances or physical systems in space. The form of the space-time infostate *locating* a physical system, S_J, *in* the most general $(s+\tau)$ *dimensional* space-time topology (*model* of the universe) is given by:

$$|\mathbf{S_J}\rangle_{space-time} = |s - space\rangle \otimes |\tau - time\rangle$$

$$= |d_1, d_2, d_3, ...d_s\rangle \otimes |t_1, t_2, ...t_\tau\rangle$$

$$= |d_1, d_2, d_3, ...d_s, t_1, t_2, ...t_\tau\rangle \, .$$

Where d_i and t_j are the observable infostates of the system with respect to the ordered 'set' of s space and τ time dimensions of the topological model being used. Note that the time coordinates are really time labels tagged to the event or its infostate associated with the configuration of system S_J. The space coordinates are also 'tagged' onto the infostate identified with this observed system. The infostate for a 'classical' system in standard $(3+1)$ space-time is a sub-space-time of the most general space-time above. This is:

$$|\mathbf{S_{3+1}}\rangle = |d_1, d_2, d_3, t_1\rangle = |x, y, z, t\rangle \, . \tag{4}$$

This state is the *space-time information component* of a more general *complete infostate* that contains not only the space-time location information but also all other possible total energy, internal configuration, material composition and environmental information. This is represented by I(total energy, configuration, composition, ..., etc.)=I(other). This term implicitly contains all the information about the all the physical subsystems forming the composite or collective state of the substance (complex system) being observed. It is important to clearly identify the processes of information mapping to the various coordinates and to have inverse functions that take one back to standard 3+1 space-times as *dimensional* information is gained or lost in the modeling process.

The complete infostate for this system is:

$$|\mathbf{S_J}\rangle_{complete} = |I(other)\rangle \otimes |d_1, d_2, ..., d_s\rangle \otimes$$

$$|t_1, t_2, ..., t_\tau\rangle = |I(other), d_1, d_2, ..., d_s, t_1, t_2, ..., t_\tau\rangle$$

$$= |I(other), space, time\rangle \, .$$

This is the **complete infostate** for the system relative to the rest of the universe. The infostate for a given configuration, α, of universe, $|\mathbf{U}\rangle_\alpha$, is then the direct product of all the infostates of the substances and space of which it is composed. We have the following equation for the α-th state of the universe with all its subsystems in their α-th states:

$$|\mathbf{U}\rangle_\alpha = |Vacuum\rangle_\alpha \bigotimes \left[\bigotimes_{J=1}^{\infty} |S_J\rangle_\alpha \right] . \tag{5}$$

This is the form of *time-independent* states of the universe that one can use in the Wheeler-DeWitt equation. The transition from one configuration to another forms a 'history' of the universe composed of a sequence of configuration changes. Cosmic 'time' is the result of 'change' not in time, but change creating information that becomes 'time' when signals are processed by observers inside the evolving universe. The transition from the (i) to the $(i+1)$ states results in the creation of information that computes into the time elapsed between those two states.

5. Computing Time

The computation of the difference between the time labels for any two infostates results in another 'bit' of information that we call the 'time' elapsed between the two observed events. From this perspective, 'time' does not exist a priori, but is in fact a computed measure of change. The construction of a 'direction' and 'dimension' for 'arrows of time' follows from the ordered sets of numbers or label states added to observed 'infostates' originating in unstable systems.

6. The Substance of Time

A general topology of time can be built from this approach that encompasses convenient theoretical constructions like 'imaginary' time, various 'arrows of time', and multiple or partial time coordinates used in higher dimensional topological models of the physical universe. Time is real in the same sense that information is real. The 'substance' of 'time' is 'change'.

7. Summary

In this brief paper I have attempted to outline a new way of thinking about time. I would like to summarize by stating the following three conclusions.

1. Change in the configurations of substance in space creates signals carrying information about their sources to other systems in space.

2. Signals are computed into *time* labels for infostates representing observed phenomena.

3. Time is used to construct space-time maps of the evolving universe and along with application of the laws of physics, a determination of the possible emerging configurations of matter can be 'computed'.

There is much more work to be done to detail how real physical systems compute time and how this new approach to time can be understood in the context of information theory applied to quantum and classical systems, causal networks, collective excitations and behaviors of complex systems, and consciousness.

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SYMMETRIES OF THE GRAVITATIONAL N-BODY PROBLEM

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We point out nice symmetries that characterize the Newtonian N-body problem expressed in configuration - momentum coordinates. For rectilinear, planar, and spatial motion (1D, 2D, and 3D problem, respectively), these symmetries form Abelian groups endowed with an idempotent structure. We generalize these properties to $n > 3$ dimensions, to any homogeneous potential, and to barycentric coordinates.

1. Introduction

The dynamics of gravitating (in Newton's sense) particle systems has established itself as the fundamental problem of celestial mechanics, if not as "the most celebrated of all dynamical problems" (Whittaker 1937). It is sufficient to mention some outstanding mathematicians who tackled it from the most various standpoints: Laplace, Lagrange, Euler, Poisson, Maxwell, Haret, Poincaré, Painlevé, Levi-Civita, Birkhoff, Smale, Kolmogorov, Arnold, Moser, Saari, Conley, McGehee, Xia, Nekhoroshev, Montgomery, Chenciner, etc. (see, for instance, Diacu and Holmes 1996). As Poincaré himself showed, the chance to fully understand and – maybe – solve it is very weak and very far. However, we can add a little bit of understanding, by emphasizing new (often unsignificant) aspects of the problem.

This paper deals with a single aspect of the N-body problem: symmetries. The vector field that characterizes the problem presents nice symmetries, which form Abelian groups endowed with an idempotent structure. The number of elements of these groups depends on the dimension of the problem ($n = 1$: rectilinear; $n = 2$: planar, etc.), but not on the number N of the particles involved.

The symmetries we point out are of much help in understanding various features of the global flow of the general problem or of a particular problem at hand.

2. Basic equations

Let us consider N particles (point masses, bodies) of masses $m_i > 0$, $i = \overline{1, N}$, moving in the n-dimensional Euclidean space under their reciprocal Newtonian attraction. Let $\mathbf{q} = (\mathbf{q_1}, \mathbf{q_2}, ..., \mathbf{q_N}) \in \mathbb{R}^{\ltimes \mathbb{N}}$ be the position (configuration) vector of the whole N-body system, and let $\mathbf{q_i} = (\mathbf{q_i^1}, \mathbf{q_i^2}, ..., \mathbf{q_i^n}) \in \mathbb{R}^{\ltimes}$, $i = \overline{1, N}$, be the position (configuration) vector of the body m_i. These vectors are considered with respect to an inertial frame.

The force (potential) function of the system is $U(\mathbf{q}) : (\mathbb{R}^{\ltimes \mathbb{N}} \backslash \underset{\neq}{\geqslant}) \to \mathbb{R}^+$,

$$U(\mathbf{q}) = \sum_{\mathbf{1 \leq i < j \leq N}} \mathbf{m_i m_j r_{ij}^{-1}}, \tag{1}$$

where $|\cdot|$ is the Euclidean norm, $r_{ij} = |\mathbf{q_i} - \mathbf{q_j}|$, whereas $\Delta = \cup_{1 \leq i < j \leq N} \Delta_{ij} = \{\mathbf{q} \in \mathbb{R}^{\ltimes \mathbb{N}} \mid \mathbf{q_i} = \mathbf{q_j}\}$ denotes the set of collision configurations. Notice that $-U$ is the potential energy of the system.

The motion of the N bodies in this inertial frame is described by the system of second-order ODE

$$\ddot{\mathbf{q}} = \mathbb{M}^{-\ltimes} \nabla \mathbb{U}(\mathbf{q}), \tag{2}$$

in which $\mathbb{M} = \sqsupset\partial\eth(\geqslant_{\ltimes}, ..., \geqslant_{\ltimes}, ..., \geqslant_{\mathbb{N}}, ..., \geqslant_{\mathbb{N}})$, each index appearing N times, whereas ∇ stands for the gradient operator $\nabla = (\partial_1, \partial_2, ..., \partial_N)$.

Defining the momentum vector of the N-body system as being $\mathbf{p} = \mathbb{M}\dot{\mathbf{q}}_\mathbf{i}$, $\mathbf{p} = (\mathbf{p_1}, \mathbf{p_2}, ..., \mathbf{p_N}) \in \mathbb{R}^{\ltimes \mathbb{N}}$, where $\mathbf{p_i} = (\mathbf{p_i^1}, \mathbf{p_i^2}, ..., \mathbf{p_i^n}) \in \mathbb{R}^{\ltimes}$, $i = \overline{1, N}$, is the momentum vector of m_i, the motion equations can be written as a system of first-order ODE:

$$\begin{aligned} \dot{\mathbf{q}} &= \mathbb{M}^{-\ltimes} \mathbf{p}, \\ \dot{\mathbf{p}} &= \nabla U(\mathbf{q}). \end{aligned} \tag{3}$$

Remark 2.1. It is well-known that the motion equations admit the ten first integrals (momentum, mass centre, angular momentum, and energy). For the angular momentum integral in $\mathbb{R}^{\ltimes}$, $n \geq 4$, see Saari (1988), Diacu (1992). But, since in this study only the motion equations are of interest for us, we shall leave the first integrals aside.

It is clear that the system (3) can be explicited under the form of a system of $2nN$ ODE as follows:

$$\frac{dq_i^k}{dt} = m_i^{-1} p_i^k,$$

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$$\frac{dp_i^k}{dt} = \sum_{j=1, j\neq i}^{N} m_j \frac{q_j^k - q_i^k}{r_{ik}^3}, \tag{4}$$

where $i = \overline{1,N}$, $k = \overline{1,n}$, and $r_{ik} = [\sum_{k=1}^{n}(q_j^k - q_i^k)^2]^{1/2}$. The system (4) constitutes the basis for our next endeavour.

3. Symmetries in natural cases

In this section we shall consider three intuitive situations: rectilinear (1D), planar (2D), and spatial (3D) motion. Only the first case is indispensable for the proofs in the next section, but the two other cases are of much help in an easier understanding of the problem.

Consider hence $n = 1$ (the rectilinear N-body problem). We can state

Proposition 3.1. *The vector field* (4) *benefits of four symmetries* $S_w = S_w(q_i^1 \mid p_i^1 \mid t)$, $i = \overline{1,N}$, $w = \overline{0,3}$, *as follows:*

$$\begin{aligned} S_0 &= I = (q_i^1 \mid p_i^1 \mid t), \\ S_1 &= (-q_i^1 \mid -p_i^1 \mid t), \\ S_2 &= (q_i^1 \mid -p_i^1 \mid -t), \\ S_3 &= (-q_i^1 \mid p_i^1 \mid -t), \end{aligned} \tag{5}$$

where I denotes the identity.

Proof. First, it is clear that, to keep the expression of the right-hand side of the second equation (4) (except the sign), q_i^1 and q_j^1 ($j = \overline{1,N}$, $j \neq i$) must have the same sign ($+$ or $-$). With this, perusing the vector field (4), we observe that it is invariant to the transformations described by (5).□

Proposition 3.2. *Out of the three non-identical symmetries* S_w, $w = \overline{1,3}$, *only two are independent.*

Proof. Consider S_1 and S_2 as being independent. One can immediately verify that $S_3 = S_2 \circ S_1$. Taking S_2 and S_3 as independent, we see that $S_1 = S_2 \circ S_3$. For S_3 and S_1 independent, we get $S_2 = S_1 \circ S_3$.□

Theorem 3.3. *The set* $G^1 = \{S_w \mid w = \overline{0,3}\}$, *endowed with the composition law "$\circ$", forms a symmetric Abelian group with an idempotent structure.*

Proof. The composition table below

$\circ$	I	S_1	S_2	S_3
I	I	S_1	S_2	S_3
S_1	S_1	I	S_3	S_2
S_2	S_2	S_3	I	S_1
S_3	S_3	S_2	S_1	I

proves the group structure. The commutativity of the composition law "$\circ$" is obvious. As regards the idempotent structure, it is easy to observe that every element is its own inverse. This completes the proof.□

Theorem 3.4. *The group* G^1 *is isomorphic to* $\mathbb{Z}_{\not 2} \oplus \mathbb{Z}_{\not 2}$.

Proof. Since G^1 is a comutative group with two generators, by the Fundamental Theorem of Abelian Groups we obtain the result.□

Let us now observe that the four symmetries (5) reduce to two pairs of symmetries with respect to t, written symbolically as

$$\begin{aligned} t \mapsto t: &\quad (+\mid+), \quad (-\mid-); \\ t \mapsto -t: &\quad (+\mid-), \quad (-\mid+). \end{aligned} \tag{6}$$

For the planar case ($n = 2$), all vectors $\mathbf{q_i} = (\mathbf{q_i^1}, \mathbf{q_i^2})$ and $\mathbf{p_i} = (\mathbf{p_i^1}, \mathbf{p_i^2})$, $i = \overline{1,N}$, are 2-dimensional. The 3-dimensional case involves $\mathbf{q_i} = (\mathbf{q_i^1}, \mathbf{q_i^2}, \mathbf{q_i^3})$ and $\mathbf{p_i} = (\mathbf{p_i^1}, \mathbf{p_i^2}, \mathbf{p_i^3})$, $i = \overline{1,N}$. It is clear that, extending the first sentence of the proof of Proposition 3.1, in the planar problem the equivalent of formulae (6) are

$$\begin{aligned} t \mapsto t: &\quad ({+}{+}\mid{+}{+}), \quad (+-\mid+-), \\ &\quad (-+\mid-+), \quad (--\mid--); \\ t \mapsto -t: &\quad ({+}{+}\mid--), \quad (+-\mid-+), \\ &\quad (-+\mid+-), \quad (--\mid{+}{+}). \end{aligned} \tag{7}$$

With the same arguments, formulae (7) can next be extended to the 3-dimensional case as

$$\begin{aligned} t \mapsto t: &\quad (+++\mid+++), \quad (+-+\mid+-+), \\ &\quad (-++\mid-++), \quad (--+\mid--+), \\ &\quad (++-\mid++-), \quad (+--\mid+--), \\ &\quad (-+-\mid-+-), \quad (---\mid---); \\ t \mapsto -t: &\quad (+++\mid---), \quad (+-+\mid-+-), \\ &\quad (-++\mid+--), \quad (--+\mid++-), \\ &\quad (++-\mid--+), \quad (+--\mid-++), \\ &\quad (-+-\mid+-+), \quad (---\mid+++). \end{aligned} \tag{8}$$

In these more-dimensional situations, imitating the proofs for the rectilinear problem, we obtain

Proposition 3.5. *In the planar case ($n = 2$), the vector field* (4) *benefits of eight symmetries* $S_w = S_w(\mathbf{q_i} \mid \mathbf{p_i} \mid \mathbf{t})$, $i = \overline{1,N}$, $w = \overline{0,7}$, $\mathbf{q_i}, \mathbf{p_i} \in \mathbb{R}^{\not 2}$.

Proposition 3.6. *Out of the seven non-identical symmetries* S_w, $w = \overline{1,7}$, *only three are independent.*

Proposition 3.7. *In the ambient spatial case ($n = 3$), the vector field* (4) *benefits of sixteen symmetries* $S_w = S_w(\mathbf{q_i} \mid \mathbf{p_i} \mid \mathbf{t})$, $i = \overline{1,N}$, $w = \overline{0,15}$, $\mathbf{q_i}, \mathbf{p_i} \in \mathbb{R}^{\not 3}$.

Proposition 3.8. *Out of the fifteen non-identical symmetries* S_w, $w = \overline{1,15}$, *only four are independent.*

Theorem 3.9. *The eight-element set* $G^2 = \{S_w \mid w = \overline{0,7}\}$ *and the sixteen-element set* $G^3 = \{S_w \mid w = \overline{0,15}\}$, *endowed with the same composition law "*$\circ$*" as* G^1, *form symmetric Abelian groups with idempotent structure.*

Theorem 3.10. *The group* G^2 *is isomorphic to* $\mathbb{Z}_{\not\epsilon} \oplus \mathbb{Z}_{\not\epsilon} \oplus \mathbb{Z}_{\not\epsilon}$, *whereas the group* G^3 *is isomorphic to* $\mathbb{Z}_{\not\epsilon} \oplus \mathbb{Z}_{\not\epsilon} \oplus \mathbb{Z}_{\not\epsilon} \oplus \mathbb{Z}_{\not\epsilon}$.

4. Symmetries in the general case

Consider now the general n-dimensional case. The main results of this paper can be stated as:

Proposition 4.1. *The vector field* (4) *has* 2^{n+1} *symmetries* $S_w = S_w(\mathbf{q_i} \mid \mathbf{p_i} \mid \mathbf{t})$, $i = \overline{1,N}$, $w = \overline{0, 2^{n+1}-1}$, $\mathbf{q_i}, \mathbf{p_i} \in \mathbb{R}^{\ltimes}$.

Proof. We shall use the induction. For $n = 1$, the property holds (see Proposition 3.1). Suppose that this result is valid for n, and check whether it remains valid for $n+1$. The fact that the property holds for n means that we have 2^{n+1} symmetries, 2^n for $t \mapsto t$, and 2^n for $t \mapsto -t$. Therefore, for the $(n+1)$-dimensional case, the vector field (4) benefits of 2^{n+2} symmetries. The proposition is proved.□

Proposition 4.2. *The set of the non-identical symmetries of the vector field* (4) *has only* 2^n *independent elements.*

Proof. Using the proof of Proposition 4.1, the statement is easy to prove.□

The next results are obvious:

Theorem 4.3. *The symmetries of the vector field* (4) *form a* 2^{n+1}*-element Abelian group,* G^n, *say.*

Corollary 4.4. *The groups corresponding to the symmetries of the vector field* (4) *have an idempotent structure.*

Theorem 4.5. *The groups* G^n *are isomorphic to* $\mathbb{Z}_{\not\epsilon} \oplus \mathbb{Z}_{\not\epsilon} \oplus ... \oplus \mathbb{Z}_{\not\epsilon}$ *(* $n+1$ *times).*

Theorem 4.6. *These properties do not depend on the number of bodies; they depend only on the dimension of the problem.*

To end, we state two more results, which generalize the above issues:

Theorem 4.7. *The symmetries we have emphasized remain valid for any homogeneous potential.*

Proof. In such a case, the expression (1) of the force function turns to

$$U(\mathbf{q}) = \sum_{\mathbf{1 \le i < j \le N}} \mathbf{m_i m_j r_{ij}^{-\alpha}}, \tag{9}$$

with $\alpha > 0$, where $\alpha = 1$ corresponds to the Newtonian model. The vector field (4) becomes

$$\begin{aligned} \frac{dq_i^k}{dt} &= m_i^{-1} p_i^k, \\ \frac{dp_i^k}{dt} &= \alpha \sum_{j=1, j\neq i}^{N} m_j \frac{q_j^k - q_i^k}{r_{ik}^{\alpha+2}}, \end{aligned} \tag{10}$$

with the same domains for the indices ($i = \overline{1,N}$, $k = \overline{1,n}$), and with the same expression for r_{ik}. Starting from (10), it is easy to check that all the stated properties, valid for $\alpha = 1$, persist for any $\alpha > 0$.□

Theorem 4.8. *The symmetries we have emphasized (for the Newtonian and for any homogeneous potential), which hold in an inertial frame, remain valid in a barycentric frame.*

Proof. It is a well-known result in the Newtonian N-body problem that, moving the origin of the coordinate system in the mass centre of the N-particle system, the expressions of the vector field and first integrals of the problem do not change (only the integration constants are modified). This result can easily be extended from the classical case $\alpha = 1$ to any α. The theorem is proved.□

5. Concluding remarks

In many previous papers we have emphasized and analyzed such symmetries in more general fields (e.g., those of Fock, Műcket-Treder, Schwarzschild - de Sitter, the Einstein PN field, the anisotropic Schwarzschild field, or general fields as the quasihomogeneous one, or that corresponding to the zonal satellite problem). But in all these cases we dealt only with the two-body problem (Mioc 2002a-d; Mioc and Pérez-Chavela 2002a,b; Mioc et al. 2002). Our present results are less general as regards the potential, but more general by the number of bodies and the dimension of the problem.

By the above quoted papers, considering separately each variable, these symmetries mean (in terms of physical motion):

- motion in the future/past;
- clockwards/counterclockwards motion (with respect to a fixed direction;
- outwards/inwards motion (with respect to the origin);
- motion above/below a fixed plane;
- positions shifted each other by different angles; etc.

As to their combination into the symmetries S_w, it is sufficient to explicit S_2 of Theorem 3.4 for $n = 1$, S_5 for $n = 2$, or S_9 for $n = 3$. These cases correspond to the reversibility of the flow: for each solution, there exists another solution that has the same coordonates and opposite velocities, all in reversed time. Corresponding situations can be found for the other combinations, too.

Of course, this is valid for $N = 2$, reducing the two-body problem to a central-force problem. But we may extrapolate these results to $N > 2$, by taking into account the motion of each individual particle with respect to the initial inertial frame or the barycentric frame.

As regards the usefulness of these symmetries, it is sufficient to mention that, for each orbit proved to exist, there are many other symmetrical orbits (from the above standpoint). This is of much help in understanding various features of the global flow of a particular problem at hand.

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THE CALCULATION OF THE INDISPENSABLE ACCURACY OF THE MEASURING OF AN EM-WAVE'S ENERGY

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The hypothesis of a "tired light" is now disclaimed by indirect signs. Within the framework of this hypothesis is demonstrated, that the energy $e = hH$ (where h is the Planck constants, H is the Hubble constant) is a value of energy that is lost by a photon in respect to one cycle of a light's wave, irrespective of a wavelength. Only having exceeding of the indicated measurement accuracy of energy, it is possible to demonstrate absence or presence of "tired" light directly in experiment. But in case of the state Universe it is possible to test this hypothesis by the obtained exponential dependence between redshift and distance up to a source.

1. Introduction

In [2, p. 487] is given the definition of the term "redshift", as a wavelength increasing (λ) of a monochromatic spectrum component of a radiation source in an observer's frame of reference as compared with wavelength (λ_0) of this component in its own frame of reference. Also there are given two facts:

A. Parameter of redshift z=$(\lambda - \lambda_0)/\lambda_0$ does not depend on a wavelength. It confirms by measurements of Doppler effect and gravitational redshift.

B. The Hubble Law is approximately linear dependence of a cosmological z_c from distance D up to far galaxies and clusters: $z_c \approx (H/c)D$, where H is so-called Hubble parameter (H_0 is the Hubble constant, the value of the Hubble parameter in our time).

Thus, the cosmological "redshift" that is considered in this article, is a wavelength increasing (λ) of a monochromatic spectrum component of a radiation source in a observer's frame of reference as compared with wavelength (λ_0) of this component in its own frame of reference, at which one parameter of shift $z = (\lambda - \lambda_0)/\lambda_0$ does not depends on a wavelength and depends on distance D up to far galaxies and clusters.

The hypothesis of a "tired light" is the assumption, that in our frame of reference the energy of a photon should decrease at increasing of covered distance.

Let's consider light, as a wave of an electromagnetic field (EMF). The wave EMF is a series cyclical transformation of electrical and magnetic fields one into another. : *Inside each quarter wave segment between zeroes of fields there is an independent periodic transferring of electrical energy in magnetic one and back* [3, item "Electromagnetic oscillations"]. In other words, the wave EMF can be esteemed as cyclical transferring process of one kind energy into another. The process is exactly cyclical - sequence of events of this process repeats. For a concreteness we would considering two successive half-of-cycle between zero points of electrical tension as a cycle of a wave EMF. Here is used the concept of a wave EMF cycle (it underlines a repetition of an energy transformation processes, instead of a wave period concept, because this term means interval of time, which one in our case is not a constant furthermore.

In the article an exponential law for changing energy of light is concluded for the Stationary Universe model by virtue of the facts **A** and **B**, whence in turn the hypothesis of a "tired light" and constancy of photon energy loss value on one cycle of a light's wave follow.

Then for the Stationary Universe model from a constancy of photon energy loss value on one cycle of a light's waves the conclusion of exponential law of change of energy of light and facts **A** and **B** is demonstrated.

2. The light "tires" in the Stationary Universe

Let's consider parameter of redshift for a far object in the Stationary Universe model.

$$z = (\lambda - \lambda_0)/\lambda_0 = \lambda/\lambda_0 - 1.$$

It does not depend on a wavelength, depends on distance R that light passed (due to the facts **A** and **B**), and does not depend on time and place of light emission (due to the stationarity). Let's designate this relation as $\lambda/\lambda_0 = F(R)$. Now we shall place an observer N

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between motionless source and motionless receiver. He shall watch a transmitted light on a wavelength λ_N, that is distinguished from λ and λ_0 due to dependence of the observed frequency from distance. That is we shall divide a ray's path R on two sections: the path from the source to the observer R_{NE} and path from the observer to the receiver R_{0N}, $(R = R_{NE} + R_{0N})$, also next relation is executed $\lambda_N/\lambda_E = F(R_{NE})$, $\lambda_0/\lambda_N = F(R_{0N})$.

Thus, the function from the sum of two parameters is equal to product of functions from these items

$$F(R_{NE} + R_{0N}) = F(R) = \lambda/\lambda_0 =$$

$$= (\lambda_N/\lambda_0)(\lambda/\lambda_N) = F(R_{\mathrm{NE}})\, F(R_{0\mathrm{N}}).$$

Such property has the exponent: $F(R) = \mathrm{e}^{R/Ch}$, where Ch is some parameter. We receive:

$\lambda(R) = \lambda_0\, \mathrm{e}^{R/Ch}$ — dependence of a wavelength;

$\nu(R) = c/\lambda(R) = \nu_0\, \mathrm{e}^{-R/Ch}$ — dependence of a frequency of wave;

$E(R) = \nu(R)h = E_0\, \mathrm{e}^{-R/Ch}$ — dependence of an photon energy.

It should be carry out for satisfaction of these formulas to the fact **B** $Ch = c/H_0$, where $H_0 = 58$ km /(sec·Mpc) is the Hubble constant, so $Ch = 17 \cdot 10^9$ l.y.

Let's remark, that the energy of a photon under these formulas should decrease at the increasing of covered distance. That is, the hypothesis the "tired light" is obtained.

Now we shall put $R = \lambda_0$ in the formula for energy of a photon. We receive a photon energy loss value on one cycle of a light's wave (for $\lambda_0 << Ch$, that is practically always):

$$\varepsilon = \mathrm{E}_{loss}(R = \lambda_0) = \mathrm{E}_0 \left(1 - \varepsilon^{-\mathrm{P}/Ch}\right) =$$

$$= h\nu_0 (1 - (1 - \lambda_0/Ch)) = h\nu_0\lambda_0/Ch = hH_0.$$

Thus, the value of photon energy loss on one cycle of a light's wave is *constant*.

3. The calculation of the value of photon energy loss, if it is constant

Let's show, that for a constant energy loss on a cycle the facts **A** and **B** are executed.

Let's designate of photon energy loss value on one cycle of a light's wave as ε, energy of a photon after n cycles — E_n, ν_n — frequency, λ_n — wavelength for E_n. Then E_0 — initial energy of a photon, ν_0 — initial frequency, λ_0 — initial wavelength. They are connected among themselves by formula:

$$E_0 = h \cdot \lambda_0 = h \cdot c/\lambda_0, \tag{1}$$

where h is the Planck's constants.

And energy E_n of a photon after n of cycles, ν_n is frequency, λ_n is wavelength are connected by the formula:

$$E_n = h \cdot \nu_n = h \cdot c/\nu_n = E_0 \cdot n \cdot \varepsilon. \tag{2}$$

Thus, quantity of transformation EMF cycles for a photon is finite.

The remainder of energy after last cycle has value smaller than ε. If this remainder is more than 0, it means, that there is an object EMF, that has no property of a wave. Therefore, the value of energy E_0 divide by ε. At the same time if we suppose, that the energy of a wave after last cycle is equal to 0, we shall receive, that last frequency is equal to 0, and last wavelength is equal to perpetuity. Therefore it is necessary to call a condition of a wave EMF when its energy becomes equal e as last cycle. After that the electromagnetic wave dissolves, disappears as object. From these reasoning follows, what for a photon with initial energy E_0 the maximum number of cycles N_{max} makes expression $(E_0 - \varepsilon)/\varepsilon$, or

$$N_{max} + 1 = E_0/\varepsilon = h \cdot \nu_0/\varepsilon. \tag{3}$$

For a photon with initial energy E_0, its life time T_{max} makes

$$T_{max} = \sum_{n=1}^{N_{max}} t_n, \tag{4}$$

where t_n is time of n-th cycle EMF.

$$t_n = 1/\nu_n = h/(\mathrm{E}_0 \cdot n \cdot \varepsilon) =$$

$$= (h/\varepsilon)/(\mathrm{N}_{max} + 1 - n). \tag{5}$$

Whence follows, that the life time of a photon T_{max} makes

$$T_{max} = \sum_{n=1}^{N_{max}} t_n = (h/\varepsilon) \sum_{n=1}^{N_{max}} (N_{max} + 1 - n)^{-1} =$$

$$= (h/\varepsilon) \sum_{n=1}^{N_{max}} n^{-1} \tag{6}$$

or

$$T_{max}(E_0) \approx (h/\varepsilon)(C + \ln(N_{max} + 1)) =$$

$$= (h/\varepsilon)(C + \ln(E_0/\varepsilon)), \tag{7}$$

where C approximately equal 0.5.

Thus life time of a photon is finite.

Let's define, in what time after radiation T the energy of a photon becomes equal E_n . For this purpose time $T_{max}(E_n)$ we shall deduct from time $T_{max}(E_0)$:

$$T = T_{max}(E_0) - T_{max}(E_n) = (h/\varepsilon)\ln(E_0/E_n). \quad (8)$$

Having designated energy of a photon in this moment $E(T)$, we receive the formula

$$T = (h/\varepsilon)\ln(E_0/E(T)). \quad (9)$$

And for expression of the photon energy as function of time after radiation we receive a formula

$$E(T) = E_0\,\mathrm{e}^{-T\varepsilon/h}. \quad (10)$$

By taking into account that distance covered by a photon during time T is equal in the Stationary Universe $R = cT$, we receive the formulas of dependence on distance of energy $E(R)$, frequency $\nu(R)$ and wavelength $\lambda(R)$:

$$E(R) = E_0\,\mathrm{e}^{-R\varepsilon/ch};$$

$$\nu(R) = E(R)/h = \nu_0\,\mathrm{e}^{-\mathrm{P}\varepsilon/ch}; \quad (11)$$

$$\lambda(R) = \lambda_0\,\mathrm{e}^{-R\varepsilon/ch}.$$

Accordingly, the formula of dependence of redshift from distance looks like

$$z = (\lambda - \lambda_0)/\lambda_0 = \mathrm{e}^{R\varepsilon/ch} - 1. \quad (12)$$

Thus, **the redshift of a frequency spectrum from one source is identical to all frequencies!**

In the Hubble law $V = R \cdot H_0$ for small distances the speed of object V is considered equal $V = z \cdot c$. As for small distances redshift is $z = \mathrm{e}^{Re/ch} - 1 = Re/ch$, we receive expression for the Hubble constant:

$$H_0 = \varepsilon/h. \quad (13)$$

Thus, the formula of energy loss looks like:

$$\varepsilon = h \cdot H_0. \quad (14)$$

We see that the lost energy on one cycle of a wave EMF transformation is proportional to the Hubble constant.

And, by analogy with a Planck formula for a quantum of light energy $E = h \cdot \nu$, it is possible to call a constant H_0 — as Hubble frequency, and ε — as the Hubble quantum, the Subquantum or the Plank-Hubble constant.

For value of a Hubble constant $H_0 = 58$ kms/(sec·Mpc) is received

$$\varepsilon = 1.2 \cdot 10^{-51}\ \mathrm{kg \cdot m^2 \cdot sec^{-2}} = 7.4 \cdot 10^{-33}\ \mathrm{eV}.$$

Because of a small value of this energy it is possible also to call it as a quantum of energy of 2 order.

On 1 meter of vacuum a part of energy loss of light makes

$$z = R\varepsilon/ch = 6 \cdot 10^{-27},$$

That not yet possible for measurement, therefore till now it is considered that the energy loss in waves EMF is absent.

Let's write once more the formula for the life time of a photon with allowance for values of ε

$$\begin{aligned} T_{max}(E_0) &= H^{-1}(1/2 - \ln(hH) + \ln E_0); \\ T_{max}(\nu_0) &= H^{-1}(1/2 - \ln H + \ln \nu_0). \end{aligned} \quad (15)$$

which for light with a 500 nm wavelength makes approximately $1.33 \cdot 10^{12}$ years.

The energy loss of a photon practically is proportional to the distance covered by it up to value 1 billion light years (6% of the Hubble length).

Frequency ν of a photon on the distance R up to a source depends from initial frequency of a photon ν_0 under the formula:

$$\nu = \nu_0\,\mathrm{e}^{-R/ch}, \quad (16)$$

where $Ch = c/H_0 = 17 \cdot 10^9$ l.y. is the Hubble length ; $H_0 = 58$ kms/(sec·Mpc) is the Hubble constant.

4. Additional reasoning for a "tired light"

Why the perpetuum mobile — ideal cyclical converter of energy is impossible? Energy losses is cause of absence its "eternity". Any actual cyclical process of the energy transformation is not endless. In the nature there is no perpetuum mobile, i.e. absolute cyclical transfer of energy (without waste of energy of that kind, which one is used in cyclical process). Even nuclear forces weaken with the time, owing to what we notice a half-life period. Why the waves EMF should be exception? Furthermore, the some sorts of decreasing of waves EMF energy are known (gravitational redshift, separation of a photon on a parts).

From the fact of existence a cosmological "redshift" follows, that in our frame of reference a frequency and an energy of a wave EMF are decreased during the time its traveling.

The energy loss should be distributed on cycles of the wave. That is, on each cycle there should be an energy loss. Otherwise, if on adjacent cycles there are not conterminous sequences of events, it are not cycles.

Let's consider one photon. By virtue of dualism it is possible to consider, that it has properties of a wave - frequency, period and wavelength. Its quantum and wave properties are tied by the Planck formula:

$E = h \cdot \nu$, where E is energy of a photon, ν is its frequency. The frequency is quantity of cycles in a unit of time.

Let's remark, that formally the same quantity of energy is on one cycle of this wave and is not dependent on energy of a photon. The same quantity of energy is on one cycle of a wave of any photon, irrespective of its frequency. For this reason the value of energy, lost by a photon, (on a cycle) also is constant.

5. Conclusions

1. The urgency of "tired" light is proved for the Stationary Universe model and the value of energy loss of a photon on one cycle of a light's wave is constant.

2. The formulas for a life time of a photon and dependence of its energy from covered distance are obtained also.

3. The view on the Hubble parameter as a frequency is offered.

4. The most surprising conclusion is received if to look at the formula of energy loss from other point of view. Energy $= \varepsilon = hH$ (where h is the Planck's constants, H is the Hubble constant) is value of energy losses of a photon on one cycle of a light's wave is not dependent on a wavelength! Therefore, it is a global physical constant! The Hubble constant has linked Macrocosms and microcosms.

5. The value of photon energy loss on one cycle of a light's wave is obtained. (for value of a Hubble constant $H = 58$ kms/(sec·Mpc): $\varepsilon = 7.4 \cdot 10^{-33}$ eV. The constancy of this loss suggests about existence of stable particles with mass approximately 10^{-69} kg. It demonstrates importance of research not only superlarge energies, but also supersmall.

6. On 1 meter of vacuum a part of energy loss of light makes $z = 6 \cdot 10^{-27}$, that not yet possible for measurement, therefore till now it is considered that the energy loss in waves EMF is absent.

7. It is possible to test the hypothesis of the Stationary Universe model by the obtained relation between redshift and distance up to a source. But for this purpose it is necessary to receive estimations of distances up to far galaxies by a way which is not dependent on model by the Universe, or way for concrete (Stationary) model of the Universe.

8. Because of the equal contribution of electrical and magnetic component into energy of a wave EMF, and that during one cycle there are 4 power transmissions between electrical and magnetic field, probably it is necessary to consider of energy loss for each such transformation at $\varepsilon/4$.

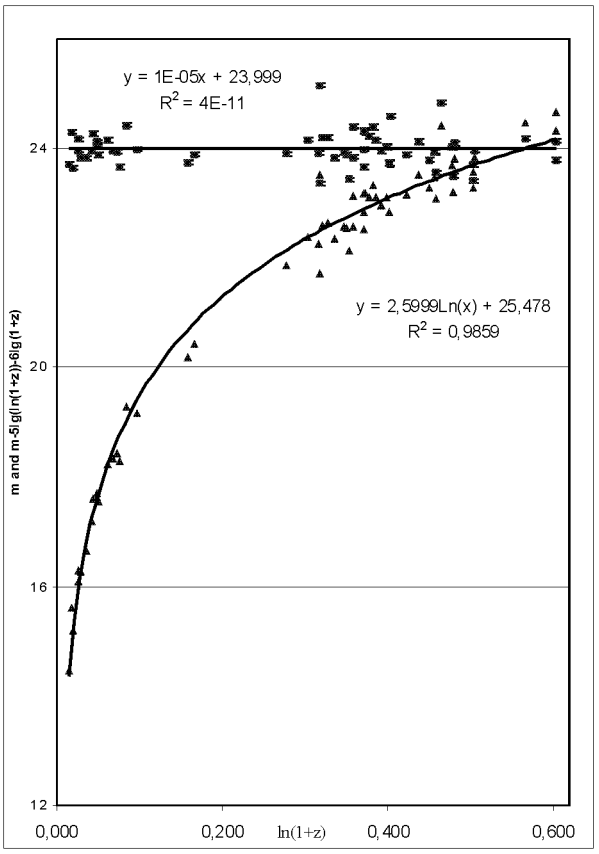

Figure 1: Magnitude - Redshift Relation among Low- and High-Redshift Supernovae

Appendix

The values all 60 magnitudes taken from the Table 1 are indicated on the Figure 1. The shift of these values on $FF = m_B^{effective} - 5 \cdot lg\,(ln\,(z+1)) - 6.167 \cdot lg\,(z+1)$ gives a constant 24.00.

The value that remains constant during billions of light years is worthy of the most intent attention.

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Table 1: The data about 60 Supernovae used by Perlmutter in his paper [5].
(Last two columns are added by me — A. Chepick)

SN	z	σ_z	m_X^{peak}	σ_X^{peak}	A_X	K_{BX}	m_B^{peak}	$m_B^{effective}$	$\sigma_B^{effective}$	$ln\,(1+z)$	FF
1992P	0.026	0.002	16.130	0.030	0.120	-0.010	16.020	16.080	0.240	0.026	23.964
1992al	0.014	0.002	14.600	0.010	0.130	-0.010	14.480	14.470	0.230	0.014	23.717
1992bc	0.020	0.002	15.200	0.010	0.070	-0.010	15.130	15.180	0.200	0.020	23.643
1992bo	0.018	0.002	15.850	0.020	0.110	-0.010	15.750	15.610	0.210	0.018	24.305
1990O	0.030	0.002	16.620	0.030	0.390	0.000	16.230	16.260	0.200	0.030	23.827
1992ag	0.026	0.002	16.590	0.040	0.380	-0.010	16.220	16.280	0.200	0.026	24.164
1992bg	0.036	0.002	17.410	0.070	0.770	0.000	16.630	16.660	0.210	0.035	23.822
1992bl	0.043	0.002	17.310	0.070	0.040	0.010	17.260	17.190	0.180	0.042	23.956
1993O	0.052	0.002	17.830	0.010	0.250	0.010	17.580	17.540	0.180	0.051	23.879
1992bh	0.045	0.002	17.670	0.040	0.100	0.010	17.560	17.610	0.190	0.044	24.274
1990af	0.050	0.002	17.920	0.010	0.160	0.010	17.750	17.630	0.180	0.049	24.058
1993ag	0.050	0.002	18.290	0.020	0.560	0.010	17.710	17.690	0.200	0.049	24.118
1992bs	0.063	0.002	18.360	0.050	0.090	0.030	18.240	18.240	0.180	0.061	24.146
1992bp	0.079	0.002	18.550	0.020	0.210	0.040	18.300	18.270	0.180	0.076	23.661
1993B	0.071	0.002	18.680	0.080	0.310	0.030	18.340	18.330	0.200	0.069	23.965
1992ae	0.075	0.002	18.610	0.120	0.150	0.030	18.430	18.430	0.200	0.072	23.940
1992aq	0.101	0.002	19.290	0.120	0.050	0.050	19.190	19.160	0.230	0.096	23.986
1992br	0.088	0.002	19.710	0.070	0.120	0.040	19.540	19.280	0.180	0.084	24.424
1992bi	0.458	0.001	22.120	0.100	0.030	-0.720	22.810	23.110	0.460	0.377	24.218
1994F	0.354	0.001	22.080	0.100	0.110	-0.580	22.550	22.380	0.330	0.303	24.161
1994G	0.425	0.001	21.520	0.210	0.030	-0.680	22.170	22.130	0.490	0.354	23.435
1994H	0.374	0.001	21.280	0.060	0.100	-0.610	21.790	21.720	0.220	0.318	23.359
1994al	0.420	0.001	22.370	0.060	0.420	-0.680	22.630	22.550	0.250	0.351	23.886
1994am	0.372	0.001	21.820	0.070	0.100	-0.610	22.320	22.260	0.200	0.316	23.913
1994an	0.378	0.001	22.140	0.080	0.210	-0.620	22.550	22.580	0.370	0.321	24.191
1995aq	0.453	0.001	22.600	0.070	0.070	-0.710	23.240	23.170	0.250	0.374	24.307
1995ar	0.465	0.005	22.710	0.040	0.070	-0.710	23.350	23.330	0.300	0.382	24.398
1995as	0.498	0.001	23.020	0.070	0.070	-0.710	23.660	23.710	0.250	0.404	24.595
1995at	0.655	0.001	22.620	0.030	0.070	-0.660	23.210	23.270	0.210	0.504	23.409
1995aw	0.400	0.030	21.750	0.030	0.120	-0.650	22.270	22.360	0.190	0.336	23.824
1995ax	0.615	0.001	22.530	0.070	0.110	-0.670	23.100	23.190	0.250	0.479	23.503
1995ay	0.480	0.001	22.640	0.040	0.350	-0.720	23.000	22.960	0.240	0.392	23.943
1995az	0.450	0.001	22.440	0.070	0.610	-0.710	22.530	22.510	0.230	0.372	23.665
1995ba	0.388	0.001	22.080	0.040	0.060	-0.630	22.660	22.650	0.200	0.328	24.193
1996cf	0.570	0.010	22.700	0.030	0.130	-0.680	23.250	23.270	0.220	0.451	23.791
1996cg	0.490	0.010	22.460	0.030	0.110	-0.720	23.060	23.100	0.200	0.399	24.028
1996ci	0.495	0.001	22.190	0.030	0.090	-0.710	22.820	22.830	0.190	0.402	23.731
1996ck	0.656	0.001	23.080	0.070	0.130	-0.660	23.620	23.570	0.280	0.504	23.705
1996cl	0.828	0.001	23.530	0.100	0.180	-1.220	24.580	24.650	0.540	0.603	24.132
1996cm	0.450	0.010	22.660	0.070	0.150	-0.710	23.220	23.170	0.230	0.372	24.325
1996cn	0.430	0.010	22.580	0.030	0.080	-0.690	23.190	23.130	0.220	0.358	24.405

Table 1: Continuation

SN	z	σ_z	m_X^{peak}	σ_X^{peak}	A_X	K_{BX}	m_B^{peak}	$m_B^{effective}$	$\sigma_B^{effective}$	$ln\,(1+z)$	FF
1997F	0.580	0.001	22.900	0.060	0.130	-0.680	23.450	23.460	0.230	0.457	23.933
1997G	0.763	0.001	23.560	0.410	0.200	-1.130	24.490	24.470	0.530	0.567	24.183
1997H	0.526	0.001	22.680	0.050	0.160	-0.700	23.210	23.150	0.200	0.423	23.888
1997I	0.172	0.001	20.040	0.020	0.160	-0.330	20.200	20.170	0.180	0.159	23.742
1997J	0.619	0.001	23.250	0.080	0.130	-0.670	23.800	23.800	0.280	0.482	24.095
1997K	0.592	0.001	23.730	0.100	0.070	-0.670	24.330	24.420	0.370	0.465	24.837
1997L	0.550	0.010	22.930	0.050	0.080	-0.690	23.530	23.510	0.250	0.438	24.128
1997N	0.180	0.001	20.190	0.010	0.100	-0.340	20.420	20.430	0.170	0.166	23.893
1997O	0.374	0.001	22.970	0.070	0.090	-0.610	23.500	23.520	0.240	0.318	25.159
1997P	0.472	0.001	22.520	0.040	0.100	-0.720	23.140	23.110	0.190	0.387	24.138
1997Q	0.430	0.010	22.010	0.030	0.090	-0.690	22.600	22.570	0.180	0.358	23.845
1997R	0.657	0.001	23.280	0.050	0.110	-0.660	23.830	23.830	0.230	0.505	23.961
1997S	0.612	0.001	23.030	0.050	0.110	-0.670	23.590	23.690	0.210	0.477	24.016
1997ac	0.320	0.010	21.380	0.030	0.090	-0.550	21.830	21.860	0.180	0.278	23.899
1997af	0.579	0.001	22.960	0.070	0.090	-0.680	23.540	23.480	0.220	0.457	23.958
1997ai	0.450	0.010	22.250	0.050	0.140	-0.710	22.810	22.830	0.300	0.372	23.985
1997aj	0.581	0.001	22.550	0.060	0.110	-0.680	23.120	23.090	0.220	0.458	23.559
1997am	0.416	0.001	21.970	0.030	0.110	-0.670	22.520	22.570	0.200	0.348	23.932
1997ap	0.830	0.010	23.200	0.070	0.130	-1.230	24.300	24.320	0.220	0.604	23.795

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GRAVITATION AND ELECTROMAGNETISM

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Maxwell's equations comprise both electromagnetic and gravitational fields. The transverse part of the vector potential belongs to magnetism, the longitudinal one is concerned with gravitation. The Coulomb gauge indicates that longitudinal components of the fields propagate instantaneously. The delta-function singularity of the field of the divergence of the vector potential, referred to as the dilatation center, represents an elementary agent of gravitation. Viewing a particle as a source or a scattering center of the point dilatation, the Newton's gravitation law can be reproduced.

1. Maxwell's equations in the Kelvin-Helmholtz representation

The general form of Maxwell's equations is given by

$$\frac{1}{c}\frac{\partial \mathbf{A}}{\partial t} + \mathbf{E} + \nabla\varphi = 0\,, \tag{1.1}$$

$$\frac{\partial \mathbf{E}}{\partial t} - c\,\nabla\times\nabla\times\mathbf{A} + 4\pi\mathbf{j} = 0\,, \tag{1.2}$$

$$\nabla\cdot\mathbf{E} = 4\pi\rho\,. \tag{1.3}$$

The Helmholtz theorem: a vanishing at infinity vector field $\mathbf{u}$ can be expanded into the sum of solenoidal $\mathbf{u}_{\rm r}$ and potential $\mathbf{u}_{\rm g}$ components. We have for the electric field:

$$\mathbf{E} = \mathbf{E}_{\rm r} + \mathbf{E}_{\rm g}\,, \tag{1.4}$$

where

$$\nabla\cdot\mathbf{E}_{\rm r} = 0\,, \tag{1.5}$$

$$\nabla\times\mathbf{E}_{\rm g} = 0\,. \tag{1.6}$$

The respective expansion for the vector potential can be written as

$$\mathbf{A} = \mathbf{A}_{\rm r} + \frac{c}{c_{\rm g}}\,\mathbf{A}_{\rm g}\,, \tag{1.7}$$

where

$$\nabla\cdot\mathbf{A}_{\rm r} = 0\,, \tag{1.8}$$

$$\nabla\times\mathbf{A}_{\rm g} = 0\,, \tag{1.9}$$

and $c_{\rm g}$ is a constant. Substitute (1.4) and (1.7) into (1.1):

$$\frac{1}{c}\frac{\partial \mathbf{A}_{\rm r}}{\partial t} + \mathbf{E}_{\rm r} + \frac{1}{c_{\rm g}}\frac{\partial \mathbf{A}_{\rm g}}{\partial t} + \mathbf{E}_{\rm g} + \nabla\varphi = 0\,. \tag{1.10}$$

Taking the curl of (1.10), we get through (1.6) and (1.9)

$$\nabla\times\left(\frac{1}{c}\frac{\partial \mathbf{A}_{\rm r}}{\partial t} + \mathbf{E}_{\rm r}\right) = 0\,. \tag{1.11}$$

On the other hand, by (1.5) and (1.8) we have

$$\nabla\cdot\left(\frac{1}{c}\frac{\partial \mathbf{A}_{\rm r}}{\partial t} + \mathbf{E}_{\rm r}\right) = 0\,. \tag{1.12}$$

If the divergence and curl of a field equal to zero, then the very field is vanishing. Hence (1.11) and (1.12) imply that

$$\frac{1}{c}\frac{\partial \mathbf{A}_{\rm r}}{\partial t} + \mathbf{E}_{\rm r} = 0\,. \tag{1.13}$$

Subtracting (1.13) from (1.10) we get also

$$\frac{1}{c_{\rm g}}\frac{\partial \mathbf{A}_{\rm g}}{\partial t} + \mathbf{E}_{\rm g} + \nabla\varphi = 0\,. \tag{1.14}$$

Similarly, expanding as well the density of the current

$$\mathbf{j} = \mathbf{j}_{\rm r} + \mathbf{j}_{\rm g}\,, \tag{1.15}$$

$$\nabla\cdot\mathbf{j}_{\rm r} = 0\,, \tag{1.16}$$

$$\nabla\times\mathbf{j}_{\rm g} = 0\,, \tag{1.17}$$

(1.2) can be broken up in two equations

$$\frac{\partial \mathbf{E}_{\rm r}}{\partial t} - c\,\nabla\times\nabla\times\mathbf{A}_{\rm r} + 4\pi\mathbf{j}_{\rm r} = 0\,, \tag{1.18}$$

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$$\frac{\partial \mathbf{E}_{\rm g}}{\partial t} + 4\pi \mathbf{j}_{\rm g} = 0\,. \tag{1.19}$$

Through (1.4) and (1.5) equation (1.3) will be

$$\nabla \cdot \mathbf{E}_{\rm g} = 4\pi\rho\,. \tag{1.20}$$

2. Wave equations

Let us derive from (1.13), (1.14), (1.18), (1.19) and (1.20) the wave equations for the solenoidal (transverse) and potential (longitudinal) components of the fields. In what follows we will use the general vector relation

$$\nabla\left(\nabla \cdot \mathbf{u}\right) = \nabla^2 \mathbf{u} + \nabla \times \nabla \times \mathbf{u}\,. \tag{2.1}$$

The wave equation for $\mathbf{A}_{\rm r}$ can be found thus. Differentiate (1.13) with respect to time:

$$\frac{1}{c}\frac{\partial^2 \mathbf{A}_{\rm r}}{\partial t^2} + \frac{\partial \mathbf{E}_{\rm r}}{\partial t} = 0\,. \tag{2.2}$$

Substitute (1.18) into (2.2). With the account of (2.1) we get

$$\frac{\partial^2 \mathbf{A}_{\rm r}}{\partial t^2} - c^2 \nabla^2 \mathbf{A}_{\rm r} = 4\pi c \mathbf{j}_{\rm r}\,. \tag{2.3}$$

The wave equation for $\mathbf{E}_{\rm r}$ can be found as follows. Differentiate (1.18) with respect to time

$$\frac{\partial^2 \mathbf{E}_{\rm r}}{\partial t^2} - c\,\nabla \times \nabla \times \frac{\partial \mathbf{A}_{\rm r}}{\partial t} + 4\pi \frac{\partial \mathbf{j}_{\rm r}}{\partial t} = 0\,. \tag{2.4}$$

Substitute (1.13) into (2.4). With the account of (2.1) we get

$$\frac{\partial^2 \mathbf{E}_{\rm r}}{\partial t^2} - c^2 \nabla^2 \mathbf{E}_{\rm r} = -\,4\pi c \partial_t \mathbf{j}_{\rm r}\,. \tag{2.5}$$

In order to find the wave equations for the potential fields we need a gauge relation. Let us postulate for the potential part of the vector potential the specific Lorentz gauge

$$\nabla \cdot \mathbf{A}_{\rm g} + \frac{1}{c_{\rm g}}\frac{\partial \varphi}{\partial t} = 0\,, \tag{2.6}$$

where in general $c_{\rm g} \neq c$.

The solenoidal part of the vector potential meets automatically the Coulomb gauge (1.8). The wave equation for $\mathbf{A}_{\rm g}$ can be found as follows. Differentiate (1.14) with respect to time:

$$\frac{1}{c_{\rm g}}\frac{\partial^2 \mathbf{A}_{\rm g}}{\partial t^2} + \frac{\partial \mathbf{E}_{\rm g}}{\partial t} + \frac{\partial \nabla \varphi}{\partial t} = 0\,. \tag{2.7}$$

Take the gradient of (2.6):

$$\nabla\left(\nabla \cdot \mathbf{A}_{\rm g}\right) + \frac{1}{c_{\rm g}}\nabla \frac{\partial \varphi}{\partial t} = 0\,. \tag{2.8}$$

Combine (2.7), (2.8) and (1.19). With the account of (2.1) we get

$$\frac{\partial^2 \mathbf{A}_{\rm g}}{\partial t^2} - c_g^2 \nabla^2 \mathbf{A}_{\rm g} = 4\pi c_{\rm g} \mathbf{j}_{\rm g}\,. \tag{2.9}$$

Next, we will find the wave equation for φ. Take the divergence of (1.14):

$$\frac{1}{c_{\rm g}}\frac{\partial \nabla \cdot \mathbf{A}_{\rm g}}{\partial t} + \nabla \cdot \mathbf{E}_{\rm g} + \nabla^2 \varphi = 0\,. \tag{2.10}$$

Combine (2.10), (2.6) and (1.20):

$$\frac{\partial^2 \varphi}{\partial t^2} - c_g^2 \nabla^2 \varphi = 4\pi c_{\rm g}^2 \rho\,. \tag{2.11}$$

The wave equation for $\mathbf{E}_{\rm g}$ we will find from the wave equations of $\mathbf{A}_{\rm g}$ and φ, using (1.14). Differentiate (2.9) with respect to time

$$\frac{\partial^2}{\partial t^2}\frac{\partial \mathbf{A}_{\rm g}}{\partial t} - c_g^2 \nabla^2 \frac{\partial \mathbf{A}_{\rm g}}{\partial t} = 4\pi c_{\rm g} \frac{\partial \mathbf{j}_{\rm g}}{\partial t}\,. \tag{2.12}$$

Take the gradient of (2.11)

$$\frac{\partial^2 \nabla \varphi}{\partial t^2} - c_g^2 \nabla^2 \nabla \varphi = 4\pi c_{\rm g}^2 \nabla \rho\,. \tag{2.13}$$

Summing (2.12) and (2.13), we get with the account of (1.14)

$$\frac{\partial^2 \mathbf{E}_{\rm g}}{\partial t^2} - c_g^2 \nabla^2 \mathbf{E}_{\rm g} = -\,4\pi \left(c_g^2 \nabla \rho + \frac{\partial \mathbf{j}_{\rm g}}{\partial t}\right)\,. \tag{2.14}$$

Thus, Maxwell's equations (1.1)-(1.3) with the specific Lorentz gauge (2.6) imply that the solenoidal and potential components of the fields propagate with different velocities. Solenoidal components propagate with the speed c of light. Their wave equations are (2.3) and (2.5). Potential components and the electrostatic potential propagate with a speed $c_{\rm g}$. Their wave equations are (2.9), (2.11) and (2.14).

3. Quasielasticity

Equations (2.3) and (2.9) have the character of the elastic equations. In this connection, the vector potential $\mathbf{A}$ can be correspondent[1] with a certain displacement field $\mathbf{s}$, and the density $\mathbf{j}$ of the current – with the density $\mathbf{f}$ of an external force . The gauge relation (2.6) is interpreted as a linearized continuity equation, in which the constant $c_{\rm g}$ has directly the meaning of the speed of an expansion-contraction wave [2]. We are interested in the interaction of two external forces $\mathbf{f}_1$ and $\mathbf{f}_2$, which produce elastic fields $\mathbf{s}_1$ and $\mathbf{s}_2$, respectively. The energy of the elastic interaction is given by the general relation

$$U_{12} = -\,\varsigma \int \mathbf{f}_1 \cdot \mathbf{s}_2 d^3x = -\,\varsigma \int \mathbf{f}_2 \cdot \mathbf{s}_1 d^3x\,, \tag{3.1}$$

where the sign minus in (3.1) corresponds to conditions of the Clapeyron theorem [3], ς is a constant.

The energy of the static interaction can be found substituting into (3.1)

$$\mathbf{s} \sim \frac{1}{c}\mathbf{A}\,, \tag{3.2}$$

$$\mathbf{f} \sim 4\pi c\mathbf{j}\,, \tag{3.3}$$

$$\varsigma \sim \frac{1}{4\pi c}\,. \tag{3.4}$$

We have for the transverse interaction

$$U_{\mathrm{r}} = -\frac{1}{c}\int \mathbf{j}_{\mathrm{r}}\cdot\mathbf{A}_{\mathrm{r}}d^3x\,. \tag{3.5}$$

Suppose that

$$c_{\mathrm{g}} >> c\,. \tag{3.6}$$

Then, through (1.7) relations (2.6) and (1.8) turn to the Coulomb gauge

$$\nabla\cdot\mathbf{A} = 0\,. \tag{3.7}$$

We have according to (1.16) and (1.17)

$$\mathbf{j}_{\mathrm{r}} = \nabla\times\mathbf{R}, \quad \mathbf{j}_{\mathrm{g}} = \nabla G\,, \tag{3.8}$$

where $\mathbf{R}$ and G are vector and scalar fields.

Using (1.15), (3.8), (3.7), (1.7) and (1.9) take the following integral by parts:

$$\int \mathbf{j}\cdot\mathbf{A}d^3x = \int (\mathbf{j}_{\mathrm{r}} + \nabla G)\cdot\mathbf{A}d^3x = \int \mathbf{j}_{\mathrm{r}}\cdot\mathbf{A}d^3x$$

$$= \int (\nabla\times\mathbf{R})\cdot(\mathbf{A}_{\mathrm{r}} + c\,\mathbf{A}_{\mathrm{g}}/c_{\mathrm{g}})d^3x = \int \mathbf{j}_{\mathrm{r}}\cdot\mathbf{A}_{\mathrm{r}}d^3x\,. \tag{3.9}$$

From (3.9) and (3.5) we get the regular expression for the energy of magnetostatic interaction

$$U_{\mathrm{r}} = -\frac{1}{c}\int \mathbf{j}\cdot\mathbf{A}d^3x\,. \tag{3.10}$$

Elementary sources of the magnetic field correspond to the two forms of the external force density $\mathbf{f}$ (3.3). The point force at $\mathbf{x}'$:

$$\mathbf{f} = 4\pi c q\mathbf{v}\delta\left(\mathbf{x}-\mathbf{x}'\right)\,, \tag{3.11}$$

and the torsion center at $\mathbf{x}'$:

$$\mathbf{f}_{\mathrm{r}} = 4\pi c a\nabla\times\left[\mu\delta\left(\mathbf{x}-\mathbf{x}'\right)\right]\,, \tag{3.12}$$

where $q\mathbf{v}$ and $a\mu$ are constant vectors, $|\mu| = 1$.

They describe a moving electric charge and a point magnetic dipole, respectively [1]. Substituting (3.11) and (3.12) into the right-hand part of the equation (2.3) we can find the fields $\mathbf{A}$ produced by these forces. Then, substituting these fields into (3.10) and (3.5), we arrive at the well-known expressions for the interaction energies of electric currents and point magnetic dipoles.

The elementary source of the longitudinal part $\mathbf{A}_{\mathrm{g}}$ of the vector potential is given by the density of the external force of the form

$$\mathbf{f}_{\mathrm{g}} = -4\pi c_{\mathrm{g}} b\nabla\delta\left(\mathbf{x}-\mathbf{x}'\right)\,, \tag{3.13}$$

where b is the strength of the dilatation center (3.13) [4].

Substitute (3.13) into the right-hand part of the static variant of the equation (2.9):

$$c_{\mathrm{g}}\nabla^2\mathbf{A}_{\mathrm{g}} = 4\pi b\nabla\delta\left(\mathbf{x}-\mathbf{x}'\right)\,. \tag{3.14}$$

With the account of (2.1) and (1.9) we get from (3.14)

$$c_{\mathrm{g}}\nabla\cdot\mathbf{A}_{\mathrm{g}} = 4\pi b\delta\left(\mathbf{x}-\mathbf{x}'\right)\,. \tag{3.15}$$

Following (3.1)-(3.4) we have for the energy of longitudinal interaction:

$$U_{\mathrm{g}} = -\frac{1}{c_{\mathrm{g}}}\int \mathbf{j}_{\mathrm{g}}\cdot\mathbf{A}_{\mathrm{g}}d^3x\,. \tag{3.16}$$

Substitute (3.13) with the account of (3.3) into (3.16):

$$U_{12} = \frac{b_1}{c_{\mathrm{g}}}\int \nabla\delta\left(\mathbf{x}-\mathbf{x_1}\right)\cdot\mathbf{A_2}d^3x =$$

$$= -\frac{b_1}{c_{\mathrm{g}}}\int \delta\left(\mathbf{x}-\mathbf{x_1}\right)\nabla\cdot\mathbf{A_2}d^3x\,. \tag{3.17}$$

Substituting (3.15) into (3.17), we get

$$U_{12} = -\frac{4\pi b_1 b_2}{c_{\mathrm{g}}^2}\int \delta\left(\mathbf{x}-\mathbf{x_1}\right)\delta\left(\mathbf{x}-\mathbf{x_2}\right)d^3x \tag{3.18}$$

$$= -\frac{4\pi b_1 b_2}{c_{\mathrm{g}}^2}\,\delta\left(\mathbf{x_1}-\mathbf{x_2}\right)\,. \tag{3.19}$$

Expression (3.19) implies, that two dilatation centers (3.15) interact with each other only if they are in a direct contact. The sign of (3.18), or (3.19), indicates that this is the attraction.

Take notice that solenoidal and potential fields are orthogonal to each other in the sense of (3.1). Indeed, using (3.8), (1.8) and (1.9), we find that

$$\int \mathbf{j}_{\mathrm{g}}\cdot\mathbf{A}_{\mathrm{r}}d^3x = \int \nabla G\cdot\mathbf{A}_{\mathrm{r}}d^3x =$$

$$= -\int G\nabla\cdot\mathbf{A}_{\mathrm{r}}d^3x = 0\,, \tag{3.20}$$

$$\int \mathbf{j}_{\mathrm{r}}\cdot\mathbf{A}_{\mathrm{g}}d^3x = \int \nabla\times\mathbf{R}\cdot\mathbf{A}_{\mathrm{g}}d^3x =$$

$$= \int \mathbf{R}\cdot\nabla\times\mathbf{A}_{\mathrm{g}}d^3x = 0\,. \tag{3.21}$$

4. Gravitation

We consider dilatation centers distributed with the volume density $bp(\mathbf{x})$. Then equation (3.15) becomes

$$c_{\mathrm{g}}\nabla\cdot\mathbf{A}_{\mathrm{g}}=4\pi bp(\mathbf{x})\ . \tag{4.1}$$

The interaction energy of the two clusters, or clouds, of dilatation centers can be found substituting delta-functions in (3.18) by the reduced densities $p(\mathbf{x})$ of the distributions. This gives

$$U_{12}=-\frac{4\pi b_1 b_2}{c_{\mathrm{g}}^2}\int p_1(\mathbf{x})\,p_2(\mathbf{x})d^3x\ . \tag{4.2}$$

Consider a weak source at $\mathbf{x}^*$, which emits dilatation centers with a sufficiently high linear velocity υ_{g}. Such a source will create a quick-formed stationary distribution of the point dilatation with the reduced density

$$p(\mathbf{x})=\frac{g}{4\pi\upsilon_{\mathrm{g}}(\mathbf{x}-\mathbf{x}^*)^2}\ , \tag{4.3}$$

where g is a universal constant.

Substituting (4.3) into (4.2), we find the interaction energy for two sources of the point dilatation

$$U_{12}=-\frac{g^2b_1b_2}{4\pi c_{\mathrm{g}}^2\upsilon_{\mathrm{g}}^2}\int\frac{d^3x}{(\mathbf{x}-\mathbf{x_1})^2(\mathbf{x}-\mathbf{x_2})^2}=$$

$$=-\frac{\pi^2g^2}{4c_{\mathrm{g}}^2\upsilon_{\mathrm{g}}^2}\,\frac{b_1b_2}{|\mathbf{x_1}-\mathbf{x_2}|}\ . \tag{4.4}$$

We will assume that each particle is a weak source of the point dilatation (3.15) or a scattering center in a dynamic sea of the point dilatation, the strength b of the source being proportional to the particle's mass. Then relation (4.4) will be a model of the Newton's law of gravitation.

Notice that in the model thus constructed we must distinguish the speed υ_{g}, with which the gravitational interaction is transmitted, and the speed c_{g} of the longitudinal wave. The latter can be interpreted as the gravitational wave.

Thus, gravitation enters into the general structure of Maxwell's equations. A gravitating center is formally modeled by a potential component of the current having the form

$$\mathbf{j}_{\mathrm{g}}=-\frac{gb}{4\pi\upsilon_{\mathrm{g}}}\nabla\frac{1}{(\mathbf{x}-\mathbf{x}^*)^2}\ . \tag{4.5}$$

And the gravitational interaction is calculated by means of the general relation (3.16), where the longitudinal component $\mathbf{A}_{\mathrm{g}}$ of the vector potential is found substituting (4.5) into the longitudinal part (2.9) of Maxwell's equations.

5. Conclusion

Maxwell's equations (1.1)-(1.3) describe both electromagnetic and gravitational fields. The transverse part of the vector potential belongs to magnetism, and longitudinal one is concerned with gravitation. Transverse fields propagate with the speed of light. The Coulomb gauge (3.7) indicates that longitudinal waves propagate in effect instantaneously, comparing with transverse waves. Choosing properly expressions for the current density, magnetic and gravitational interactions can be modeled. An elementary agent of the gravitational interaction corresponds to the dilaton, which is a delta-function singularity (3.15) of the field of the divergence of the vector potential . The sources of longitudinal and transverse fields do not interact with each other. This signifies that gravitation can not be detected with the aid of light.

In the end it should be noted that some of the questions considered here and in [1] were recently approached in [5].

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ELECTROMAGNETIC INFLUENCE ON GRAVITATIONAL MASS – THEORY, EXPERIMENTS AND MECHANISM OF THE SOLAR CORONA HEATING

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Based on the model of Expansive Nondecelerative Universe, the aim of the present contribution is to contribute to the theoretical rationalization of some experiments, in particular of those performed by Podkletnov and de Aquino and devoted to the gravitational mass cessation, to offer a mechanistic explanation of the Solar corona heating, and to propose an experiment to verify the explanation of the heating in the Earth conditions.

1. Introduction

Among the problems of current physics, issues concerning gravity are still ranked in "top ten". Theoretical approaches focused on elaboration of a theory of quantum gravitation unifying all four (or more?) fundamental forces are in progress, successful completion of the theory seems to be, however, far beyond the horizon. Simultaneously with theoretical attempts (for a general survey, see [1]), experiments aimed at influencing the gravitational mass by other forces have been developed and tentatively explained [2-8]. The gravity has penetrated also into chemistry as manifested by space-craft experiments (preparation of compounds, alloys or mixtures that, due to the gravitational force acting at the Earth, cannot be prepared in the Earth conditions) as well as by a newly elaborated rationalization of some quantum chemical effects [9-10].

A carefull inspection of the contributions devoted to experiments involving gravitational effects [2-7] may lead the reader to a conclusion on the necessity to introduce a theoretical approach different of those applied in the original papers. It concerns, namely, an approach based on the general theory of relativity and benefiting from the ability to localize and quantify the gravitational energy. The Expansive Nondecelerative Universe (ENU) model [8,11-13] satisfies the above requirements. The purpose of the present contribution is to contribute to the rationalization of some experiments, in particular of those performed by Podkletnov [2-4] and de Aquino [5-7], to offer a mechanistic explanation of the Solar corona heating, and to propose an experiment enabling to verify the explanation in the Earth conditions.

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2. Podkletnov's phenomenon

In the papers by Podkletnov [2-4] a detection of an anomalous force originating at a high-voltage discharge directed from a superconductive emitter to a target electrode is described. The effect has been attributed to forces of gravitational nature. At the Podkletnov's experiments, the following conditions were applied: the discharge time was 10^{-5} to 10^{-4} s, the current peak value at the discharge was of the order 10^4 A, the voltage varied from 500 kV to 2 MV, the interelectrode distance ranged from 15 cm to 2 m, the total charge of the emitter was about 0.1 C, and the discharge energy approached 10^5 J. The formed gravitational impulse propagated as a coherent beam in the same direction as the discharge. It penetrates through different media, apparently without any energy loss and caused a deflection of a 10 - 50 g pendulum. The energy of the deflection was independent on the pendulum material and mass, and depended on the voltage only.

One of the possible explanations of the Podkletnov's phenomenon was offered in [8]. At the Podkletnov's experiments, a mean intensity of the electrostatic field was

$$E \cong 2.5 \times 10^6 \text{ V m}^{-1}, \tag{1}$$

which corresponds to a mean energy density

$$\varepsilon_e \cong 27 \text{ J m}^{-3}. \tag{2}$$

As shown in [8], energy density of gravitational field at

the Earth surface is

$$|\varepsilon_g| = \frac{Rc^4}{8\pi G} = \frac{3m_{(Earth)}c^2}{4\pi a r^2_{(Earth)}} = 24.29 \text{ J m}^{-3}, \tag{3}$$

where R is the scalar curvature, a is the gauge factor, $m_{(Earth)}$ and $r_{(Earth)}$ are the Earth mass and radius, respectively. Based on (2) and (3) it follows

$$\varepsilon_e \cong \varepsilon_g. \tag{4}$$

The Earth gravitational field interferes with the electrostatic field created in the Podkletnov's equipment which leads to a local cessation of the gravitational field. The corresponding deviation from the vertical direction of the gravity causes the observed pendulum deflection. In [8] it was proved that the deflection in vertical direction, h_v is described by

$$h_v \cong \frac{Q}{g}, \tag{5}$$

where g is the Earth surface gravitational acceleration (9.80665 m s^{-2}) and Q is the total charge of the emitter.

3. Solar corona

The temperature profile of the Sun and its surroundings belongs still to the enigmas of physics. At the core of the Sun, the temperature reaches about 15 million K which is understandable since energy is created in the Sun. Passing from the core to the surface the temperature decreases and at the Sun's surface it is about 5,500 K. Next part (outside of the chromosphere) is corona. There is no source of energy, its temperature, however, is extremely high (about 1 million K [14]). The question is, what mechanism is applied at the corona heating, preserving thus its temperature? This part offers a possible explanation.

The mean magnetic field intensity at the Sun's surface is [15]

$$\bar{H} \cong 10^2 \text{ A m}^{-1} \tag{6}$$

and during some processes the intensity may increase in sunspots up to

$$H_{\max} \cong 10^5 \text{ A m}^{-1}. \tag{7}$$

A magnetic field intensity with a density identical to the gravitational energy density on the Sun's surface is the critical density H_{crit} reaching

$$H_{crit} \cong 4 \times 10^4 \text{ A m}^{-1}, \tag{8}$$

which corresponds to the critical magnetic induction

$$B_{crit} \cong 5 \times 10^{-2} \text{ T}. \tag{9}$$

Interference of the gravitational and magnetic fields can lead to origination of a gravitational impulse that can increase the kinetic energy of the particles forming the Solar corona, i.e. its temperature. The mechanism of the corona "heating" may be, therefore, similar to that of the Podkletnov's phenomena. The difference is that instead of pendulum and electrostatic discharge, rather plasma particles and magnetic impulses are in action, i.e.

$$\frac{3m_{(Sun)}c^2}{4\pi a r^2_{(Sun)}} = \frac{B^2_{crit}}{2\mu_o}. \tag{10}$$

At the Podkletnov's experiments, along with a high voltage, also a discharge must be created. Similarly, the Sun's magnetic field with B_{crit} must influence on the particles (electrons) and induce their precession with the frequency

$$\omega_e = \frac{B_{crit}e}{m_e}, \tag{11}$$

where m_e is the electron mass. In order no avoid damping, the mentioned precession must equal to the plasma frequency ω_{pl} [16] in a given region

$$\omega_e = \omega_{pl} = \left(\frac{e^2 n_{e(Sun)}}{\varepsilon_o m_e}\right)^{1/2}, \tag{12}$$

where $n_{e(Sun)}$ denotes a concentration of the electrons with a given precession frequency in a space.

In order the Podkletnov's phenomenon may occur, a region with the concentration of the plasma electrons of $n_{e(Sun)}$ must be just near the Sun surface where at B_{crit} given by (9) the electrons will have identical precession and plasma frequencies. Based on (3)–(5) it follows

$$n_{e(Sun)} = \frac{3m_{(Sun)}}{2\pi m_e a r^2_{(Sun)}} \cong 10^{16} \text{ m}^{-3}. \tag{13}$$

Experimental observation of the Sun and its environment has brought an evidence that such a region (the boundary of chromosphere and corona) really exists. Thus, just in this region, conditions for the corona heating by the Podkletnov's phenomenon are satisfied (as a matter of fact, there is no other place where they might exist).

4. A model experiment

The above conclusions on the conditions required to heat the Solar corona may be experimentally verified in a laboratory. Here, such an experiment is suggested. The gravitational energy density at the Earth surface (24.29 J m^{-3} [8]) equals to magnetic field density when

$$H_{crit(Earth)} = 7.000 \times 10^3 \text{ A m}^{-1} \tag{14}$$

or

$$B_{crit(Earth)} = 8.796 \times 10^{-3} \text{ T}. \tag{15}$$

Applying (13) to the conditions at the Earth surface leads to the value of concentration of electrons in the plasma with identical the plasma and electron precession frequencies

$$n_{e(Earth)} \cong 5.5 \times 10^{14}\ \mathrm{m}^{-3}. \tag{16}$$

Such a concentration of free electrons is present in a sample of hydrogen containing 3.9×10^{21} hydrogen atoms in a cubic meter when being at the temperature of 3000 K. This sample is exposed to a pulsing magnetic field with B_{crit} given by (15). In the direction of the magnetic poles, a second sample of hydrogen (room temperature, concentration about 10^{20} in a cubic meter) will be placed next to the first sample. After some time of magnetic field pulsing, the temperature of the second sample should increase. The temperature of the control samples placed in other directions should be preserved.

5. Rationalization of experiments performed by de Aquino

Stemming from the special relativity theory and classical physics, de Aquino [17] discussed relations between the inertial and gravitational masses. Using a very detailed and precise mathematical treatment he manifested that in the absence of electromagnetic field, the masses are identical. In the presence of such a field, the gravitational mass may be reduced or even nullified.

In his experiment [5], de Aquino worked with dics-shaped organic luminescent material. According to quantum statistical mechanics, an average number of photons forming the photon gas inside a luminescent material is given as

$$\bar{N}_{(h\nu)} = \left(\exp(\lambda_e/\lambda_{(h\nu)}) - 1\right)^{-1}, \tag{17}$$

where λ_e and $\lambda_{(h\nu)}$ are the Compton wavelength of the electron,

$$\lambda_e = 2.42 \times 10^{-12}\ \mathrm{m} \tag{18}$$

qand a mean wavelength of a photon emitted or absorbed by a luminescent material, respectively.

In the experiment, a material emitting blue light with

$$\lambda_{(h\nu)} = 461\ \mathrm{nm} \tag{19}$$

was used. The radiation output of the material is expressed as

$$P_{(h\nu)} = \bar{N}_{(h\nu)} h\nu^2 = \frac{hc^2}{\lambda^2_{(h\nu)}\left(\exp((\lambda_e/\lambda_{(h\nu)}) - 1\right)}. \tag{20}$$

Based on (18)–(7) it can be calculated that for the radiation of 461 nm wavelength

$$P_{(h\nu)} \cong 56\ \mathrm{W}. \tag{21}$$

The ENU model provides a general relation [18] for the gravitational output of a body with the mass m

$$|P_g| = \frac{d}{dt}\int \frac{Rc^4}{8\pi G} dV = \frac{mc^2}{t_c}, \tag{22}$$

where the present cosmological time calculated by the ENU model is [12]

$$t_c = 4.296 \times 10^{17}\ \mathrm{s}. \tag{23}$$

A general condition for the interference of the electromagnetic and gravitational fields may be expressed as

$$P_{(h\nu)} = |P_g|\,. \tag{24}$$

Stemming from (7)–(9), the ENU provides a total mass of the electroluminescent disc

$$m_{(disc,calc)} \cong 267\ \mathrm{kg}. \tag{25}$$

In the de Aquino's experiment [5] the discs of a mass

$$m_{(disc,\mathrm{exp})} \cong 264\ \mathrm{kg} \tag{26}$$

were used. Thus, the ENU based calculated and experimental masses coincide.

If both approaches are consistent, equation (8) can be exploited to calculate a more precise value of the cosmological time and such a calculation leads to

$$t_c = 4.169 \times 10^{17}]\ \mathrm{s} = 1.32 \times 10^{10}\ \mathrm{years}. \tag{27}$$

At the same time, the above rationalization leads to a conclusion on a time dependence of the vacuum permittivity ε_o and permeability μ_o.

In the Podkletnov's experiments, the electromagnetic field interferes with the Earth gravitational field. In case of the experiments carried out by de Aquino, the electromagnetic field interferes with the gravitational field of a body.

Relation (9) is applicable also for the experiment [5] with radiation of extra-low frequency (ELF) acting on a ferromagnetic material. It this case it must hold

$$\eta R_a I^2 = \frac{m_{Fe} c^2}{t_c}, \tag{28}$$

where R_a is the antenna impedance (116 mΩ), I is the current (130 A), m_{Fe} is the mass of iron powder (29 kg). In such a case the absorption coefficient is

$$\eta = 3.17 \times 10^{-3}. \tag{29}$$

For the iron powder used at the experiment, conductivity gradient $\sigma = 10\ \mathrm{S\ m^{-1}}$, $\mu = 75\mu_o$ and for the frequency 60 Hz, the skin layer thickness is

$$\delta = \left(\frac{2}{\omega\sigma\mu}\right)^{0.5} \cong 2.43\ \mathrm{m}. \tag{30}$$

The thickness of the iron powder then must be

$$d = \eta\delta \cong 8\ \mathrm{mm}, \tag{31}$$

which is in an excellent agreement with the experimental value.

The above mentioned ideas may be applied also in the field of thermodynamics. In the centre of stars (e.g. the Sun) the gravitational and radiation energies must be balanced, i.e.

$$\left|\frac{3m_{(Sun)}c^2}{4\pi a r_{g(Sun)}^2}\right| = \frac{4\sigma_{SB}T_{(Sun)}^4}{c}, \tag{32}$$

where $r_{g(Sun)}$ is the gravitational radius of the Sun ($\cong 3\times 10^3$ m), σ_{SB} is the Stefan-Boltzmann constant (5.67×10^{-8} kg s^{-3} K^{-4}), $T_{(Sun)}$ is the temperature in the centre of the Sun. Relation (12) leads to

$$T_{(Sun)} \cong 1.5\times 10^7 \text{ K}, \tag{33}$$

which is identical (within the degree of accuracy of its estimation) to that published in various literature sources [e.g. 19].

In one of the latest de Aquino's contributions [20], changes in the gravitational mass of a body due to its interaction with electromagnetic radiation of very low frequency are described and measured. The used antenna was a half-wave dipole encapsulated in an iron sphere (made from 99.95% iron, $\mu = 5000\mu_o$, $\sigma = 1.03\times 10^7$ S m^{-1}). The antenna impedance was 8.29×10^{-6} Ω and the 9.9 mHz radiation emitted by the antenna was completely absorbed by the iron along a critical thickness 0.110 m.

De Aquino mathematically predicted a dependence of the iron sphere gravitational mass on current, and experimentally proved that the total mass of the iron sphere (inertial mass of 60.5 kg) is nullified just at the current of 8.51 A.

To rationalize this experiment case, instead of comparison of the outputs expressed by equation (9) rather energies are to be related. The reason is a relatively long time of radiation passage (about 16 s) through the iron layer.

The gravitational energy density associated with a 60.5 kg iron sphere with a 0.110 m radius is

$$|\varepsilon_g| = \frac{3m_{Fe}c^2}{4\pi a\delta^2}. \tag{34}$$

An amount of the gravitational energy in the sphere is

$$|E_g| = \frac{m_{Fe}c^2\delta}{a}. \tag{35}$$

At interference of the gravitational and electromagnetic fields of iron sphere, each iron atom absorbs the energy $h\nu$ and thus the total electromagnetic energy in the iron sphere will be

$$E_{(h\nu)} = \frac{m_{Fe}}{m_{(atom)}}h\nu, \tag{36}$$

where $m_{(atom)}$ is the mass of an iron atom. Identity of (14) and (15) leads to

$$h\nu = \frac{m_{(atom)}c^2\delta}{a}. \tag{37}$$

Relation (37) is valid when the gauge factor

$$a = 1.399\times 10^{26} \text{ m}, \tag{38}$$

which is in excellent agreement with its value calculated using the ENU model [12]. This value corresponds to the cosmological time

$$t_c = 1.48\times 10^{10} \text{ years}. \tag{39}$$

In this way, the de Aquino experiments and the ENU model provide an interval of the cosmological time

$$t_c = (1.32 - 1.48)\times 10^{10} \text{ years}. \tag{40}$$

In case of more experimental data available, the cosmological time can be calculated more precisely.

The above conclusions can be taken as a challenge both for those planning and performing experiments and those elaborating theoretical approaches. The given data manifest a mutual coherence of the Podkletnov's, de Aquino's and ours approaches. In addition, they bring a clear evidence of the necessity to exploit the general theory of relativity so as to understand and rationalize experiments devoted to gravitational mass changes.

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SUPREMUM OF THE INTERACTION SPEED OF THE MATTER

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Explanations of dependence on distance both for the w-factor of an absolute magnitude Type Ia Supernovae curve, and for till now not explained s-factor are given on the basis of the offered hypothesis about inequality of light's speed in vacuum and supremum of the interaction speed of a matter.

1. Introduction

In "The Field Theory" by Landauh, Lifshits in the paragraph "Speed of interaction distribution" it is told: "Speed of interaction distribution is a universal constant. This constant speed is, as it will be shown further, the speed of light traveling in emptiness simultaneously... Association of the relativity principle with finiteness of the interaction speed refers to as the relativity principle of Einstein".

It is appeared in experiments that speed of light in vacuum and a constant of interaction speed (in Lorentz's transformations) are close. The measurement accuracy of the speed of light (in experiments with long-basic interferometers and Cherenkov radiation) makes up some decimeters per second, that is 10^{-9} c.

It is necessary to note that in those experiments only the speed of distribution of an electromagnetic interaction was checked. Other kinds of matter interaction were not checked. Therefore for generalization of all kinds of interaction speeds it is necessary to consider supremum of interaction speed.

Let's designate through "c_L" a value of supremum to distinguish it from "c" - value of the speed of light.

Einstein has acted very superbly, having postulated a constancy of light's speed. Because both the proof to this, and the contradiction to this it is practically impossible to find. **The Postulation of a light's speed constancy** is known: "*Speed of light in vacuum in all inertial systems of reference (ISR) is identical and does not depend on speed of a source and the receiver of light*". As to presence**of the theoretical proof** of that that the constant "c" in the equations of Lorentz's transformation is speed of light, such proof simply is not exist! It would be interesting to discover, why Maxwell, knowing nothing about a constancy of light's speed in vacuum, put in his equations a value of speed of an electromagnetic wave in emptiness (or in ether) as a constant.

2. The formulation of a postulate

Einstein has allocated light by his postulate into a separate category of the phenomena, having idealized material object - a photon. To return light in a bosom of material particles, it is necessary and enough to count that the top limit of interaction speed of the matter is a constant. That the speed of interaction cannot be infinite, it was clear for a long time. It is clear also, that the supremum of speeds of interaction even on its physical sense fits much more for a role of constant value, which is independent of speed of a source and the observer, than speed of any carrier of concrete interplay.

The offered formulation of a postulate sounds so:

The supremum speed of interaction of the matter does not depend on speed of the observer of these interactions and speed of sources of observable interactions, and is a constant in all inertial systems of reference.

In comparison with the existing formulation there was only a replacement of the term "light" by term "interaction").

In this case there will be true both a constancy of a four-dimensional interval, and Lorentz's transformation, both the formula of the sum of speeds, and special and general theories of a relativity (TR).

Whether it is possible to agree with such formulation of the postulate?

In fact if to count speed of light equals to these supremum (as now it is considered, and it is an additional postulate) so all is reduced to that TR that we have and we investigate already almost 100 years. Landauh and Lifshits act so, uniting two postulates under the name "a principle of a relativity of Einstein".

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3. Consideration of the postulate under condition $c < c_L$

Why does it is impossible to consider that speed of light is less by a few nanometers per second than the supremum?

Below it is offered to consider a variant of discrepancy c and c_L.

Clearly, that speed of light now is not a constant. In different ISR speed of light becomes various. Under the formula of the speeds sum a speed of the photon radiated by the moving source becomes more in a direction of a source velocity, and it becomes less - in an opposite direction. If speed of a source to aspire to light's speed, then speed of photons which leaving "back" will decrease approximately under the law $c_2 = c_L\left(1 - 2\left(c_L - c_1\right)/\left(c_L - v\right)\right)$, where v is speed of a source, c_1 is speed of light in ISR of the source, c_2 is speed of light in ISR of the receiver. We have not "seen" such change of light's speed, for example, for speed of a source $v < 0.9c_L$ if $(1 - c_1/c_L)$ would be less than $5 \cdot 10^{-11}$. Hence, for real speeds of sources we shall not see change of light's speed, especially if photons move "forward".

Conclusions from GR and TR remain completely true regarding, not concerning distribution of light. But also in the rest it is possible to specify such changes in formulas, which basically will bring only in replacement of a part of designations c on c_L. In particular, formula of Doppler law now will be so: $f = f0 \cdot \left[1 - \left(v/c_L\right)^2\right]^{1/2/[1-(v \cdot cosa)/c]}$.

Maxwell Equations will be stay invariant relative to any ISR, as in fact a value of light speed "c" is not a constant in them now, but a variable equal to speed of light in considered ISR.

But cannot be:

- Zero mass of rest;

- Infinity in energy and mass of particles at approach speed of light (not c_L).

4. Consequence from the hypothesis

Whether speed of light that has come to us from far ($z > 1$) galaxies was measured sometime? I'm sure that it was not measured, as search of the light speed change is unpromising business (as shown higher). But a processes of different duration we can observe as consequence of the light speed change, though we do not know their explanation.

Recently found out an expansion phenomenon (w-factor) of a light curve for absolute magnitude of Type Ia Supernovae would be considered as the brightest proof of the universe expansion if it was not accompanied by the not explained stretch-factor (s-factor) [1].

The environment of a Supernovae scatters in all parties with huge speed. Therefore speed of the photons flying in our direction, is different. We shall designate average speed of a photon from the distant source as c, and a range of speeds $[c - \sigma, c + \sigma]$. We shall consider that distribution of photons density on speed is defined by some average function $F\left(v, c, \sigma\right)$.

Let's assume that value c does not depend neither on time, nor from length of a wave; and distance R from a source up to the receiver during supervision is changing insignificantly (much less than R). Let n is the general number of the photons accepted in unit of time (depends on an epoch of reception t'). Let time t (an epoch of radiation) and t' are defined in ISR of the receiver, and $t' = t + R/c$. N is the general number of photons, radiated in unit of time that then will get in the receiver; N depends on time of radiation t ($t = 0$ corresponds to the peak radiation moment).

Then

$$n\left(t'\right) = \int N\left(t + R/v - R/c\right) F\left(v, c, \sigma\right) dv$$

The size of shift $R/v - R/c = (R/c)\left(c/v - 1\right)$ is measured in day and means an epoch concerning time t from which there come photons to the receiver at the moment of time t'. Accordingly, the further Supernovae is situated, the more an epoch exist photons will come from.

On the contrary, for very close Supernova the value of shift will be practically equal 0 for any speed v, that is, simple conformity between epoch of radiation and reception is established. Accordingly, the further Supernovae is situated, the more an epoch exist photons will come to from one epoch of radiation.

5. Conclusions

All this results to that:

1. The width of a light curve increases proportionally to distance both for all spectrum, and for a separate range (w-factor).

2. The peak of accepted radiation (absolute luminosity) decreases proportionally to distance both for all spectrum, and for a separate range (s-factor), and the factor of proportionality depends on absolute luminosity in this range (the formula (2) in NKP2002).

3. Color $B - V$ at peak B-band is proportional to distance and it is a consequence of the formula (2) as a subtraction of luminosities (the formula (3) in NKP2002).

4. As result of these reasons it is possible to estimate value c_L, assuming, that the maximal speed $v_{max} = 2c/\left(1 + c^2/c_L^2\right)$ and that the width of a light curve makes up 60 day for a Supernovae that situated on distance $R = 3 \cdot 10^9$ l.y.:

$$2\left(R/c\right)\left(1 - c/v_{max}\right) = 60\ day$$

Whence $c = c_L \left(1 - 3 \cdot 10^{-11}\right)$.

5. In passing it is found out, why in the first days after explosion the width of a spectrum for far Supernovae is less, than for a close one, even without taking into account the w-factor.

6. One more capability for check of this hypothesis is concluded in an estimation of speed and size of jets from active galaxies. Size of a leaving jet should be less (or would be closer to a core) than size of jet approaching to us. And in an incipient state - the leaving jet can be not seen at all.

Though I like this hypothesis, I am compelled to tell, that there is one more opportunity of an explanation $w-$ and s-factors - a hypothesis about difference of real speed of light from speed of light in vacuum owing to optical density of the intergalactic environment.

But, probably, effects $w-$ and s-factors turn out because of total influence of these reasons.

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SOME MATHEMATICAL BASES FOR NON-COMMYTATIVE FIELD THEORIES[1]

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Misconceptions have recently been found in the definition of a partial derivative (in the case of the presence of both explicit and implicit dependencies of the function subjected to differentiation) in the classical analysis. We investigate the possible influence of this discovery on quantum mechanics and the classical/quantum field theory. Surprisingly, some commutators of operators of space-time 4-coordinates do *not* equal to zero. Thus, we provide the bases for new-fashioned noncommutative field theory.

To the best of my knowledge, the assumption that the operators of coordinates do *not* commute $[\hat{x}_\mu, \hat{x}_\nu]_- \neq 0$ has been made by H. Snyder [1]. The Lorentz symmetry thus may be broken. Much interest has recently been attracted to this idea [2, 3] in the context of "brane theories".

Moreover, the famous Feynman-Dyson proof of Maxwell equations [4] contains intrinsically the non-commutativity of velocities $[\dot{x}_i(t), \dot{x}_j(t)]_- \neq 0$ that also may be considered as a contradiction with the well-accepted theories.

On the other hand, it was recently discovered that the concept of partial derivative is *not* well defined in the case of both explicit and implicit dependence of the corresponding function, which the derivatives act upon [5, 7] (see also the discussion in [6]). The well-known example of such a situation is the field of an accelerated charge [8].[3]

Let us study the case when we deal with explicite and implicite dependencies $f(\mathbf{p}, E(\mathbf{p}))$. It is well known that the energy in the relativism is connected with the 3-momentum as $E = \pm\sqrt{\mathbf{p}^2 + m^2}$; the unit system $c = \hbar = 1$ is used. In other words, we must choose the 3-dimensional hyperboloid from the entire Minkowski space and the energy is *not* an independent quantity anymore. Let us calculate the commutator of the whole derivative $\hat{\partial}/\hat{\partial}E$ and $\hat{\partial}/\hat{\partial}p_i$.[4] In the general case one has

$$\frac{\hat{\partial} f(\mathbf{p}, E(\mathbf{p}))}{\hat{\partial} p_i} \equiv \frac{\partial f(\mathbf{p}, E(\mathbf{p}))}{\partial p_i} + \frac{\partial f(\mathbf{p}, E(\mathbf{p}))}{\partial E}\frac{\partial E}{\partial p_i} . \quad (1)$$

Applying this rule, we surprisingly find

$$[\frac{\hat{\partial}}{\hat{\partial} p_i}, \frac{\hat{\partial}}{\hat{\partial} E}]_- f(\mathbf{p}, E(\mathbf{p})) =$$

$$= \frac{\hat{\partial}}{\hat{\partial} p_i}\frac{\partial f}{\partial E} - \frac{\partial}{\partial E}(\frac{\partial f}{\partial p_i} + \frac{\partial f}{\partial E}\frac{\partial E}{\partial p_i}) =$$

$$= \frac{\partial^2 f}{\partial E \partial p_i} + \frac{\partial^2 f}{\partial E^2}\frac{\partial E}{\partial p_i} - \frac{\partial^2 f}{\partial p_i \partial E} -$$

$$- \frac{\partial^2 f}{\partial E^2}\frac{\partial E}{\partial p_i} - \frac{\partial f}{\partial E}\frac{\partial}{\partial E}(\frac{\partial E}{\partial p_i}) . \quad (2)$$

So, if $E = \pm\sqrt{m^2 + \mathbf{p}^2}$ and one uses the generally-accepted representation form of $\partial E/\partial p_i = p^i/E$, one has that the expression (2) appears to be equal to $(p^i/E^2)\frac{\partial f(\mathbf{p}, E(\mathbf{p}))}{\partial E}$. Within the choice of the normalization the coefficient is the longitudinal electric field in the helicity basis (the electric/magnetic fields can be

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[3] First, Landau and Lifshitz wrote that the functions depended on t' and only through $t' + R(t')/c = t$ they depended implicitly on x, y, z, t. However, later (in calculating the formula (63.7)) they used the explicit dependence of R on the space coordinates of the observation point too. Chubykalo and Vlayev claimed that the time derivative and curl do *not* commute in their case. Jackson, in fact, disagreed with their claim on the basis of the definitions ("the equations representing Faraday's law and the absence of magnetic charges ... are satisfied automatically"; see his Introduction in [6b]). But, he agrees with [8] that one should find "a contribution to the spatial partial derivative for fixed time t from explicit spatial coordinate dependence (of the observation point)." Škovrlj and Ivezić [6c] calls this partial derivative as '*complete* partial derivative'; Chubykalo and Vlayev [6a], as '*total* derivative with respect to a given variable'; the terminology suggested by Brownstein [7] is 'the *whole*-partial derivative'.

[4] In order to make distinction between differentiating the explicit function and that which contains both explicit and implicit dependencies, the 'whole partial derivative' may be denoted as $\hat{\partial}$.

derived from the 4-potentials which have been presented in [9]). On the other hand, the commutator

$$[\frac{\hat{\partial}}{\hat{\partial} p_i}, \frac{\hat{\partial}}{\hat{\partial} p_j}]_- f(\mathbf{p}, E(\mathbf{p})) = \\ = \frac{1}{|E|^3} \frac{\partial f(\mathbf{p}, E(\mathbf{p}))}{\partial E} [p_i, p_j]_- \,. \qquad (3)$$

This may be considered to be zero unless we would trust to the genious Feynman. He postulated that the velocity (or, of course, the 3-momentum) commutator is equal to $[p_i, p_j] \sim i\hbar\epsilon_{ijk}B^k$, i.e., to the magnetic field.[5]

Furthermore, since the energy derivative corresponds to the operator of time and the i-component momentum derivative, to $\hat{x}_i$, we put forward the following anzatz in the momentum representation:

$$[\hat{x}^\mu, \hat{x}^\nu]_- = \omega(\mathbf{p}, E(\mathbf{p}))\, F^{\mu\nu}_{||} \frac{\partial}{\partial E} \,, \qquad (4)$$

with some weight function ω being different for different choices of the antisymmetric tensor spin basis.

In the modern literature, the idea of the broken Lorentz invariance by this method concurrs with the idea of the *fundamental length*, first introduced by V. G. Kadyshevsky [10] on the basis of old papers by M. Markov. Both ideas and corresponding theories are extensively discussed, e.g. [11]. In my opinion, the main question is: what is the space scale, when the relativity theory becomes incorrect.

Conclusions

We found that the commutator of two derivatives may be *not* equal to zero. As a consequence, for instance, the question arises, if the derivative $\hat{\partial}^2 f/\hat{\partial} p^\nu \hat{\partial} p^\mu$ is equal to the derivative $\hat{\partial}^2 f/\hat{\partial} p^\mu \hat{\partial} p^\nu$ in all cases?[6] The presented consideration permits us to provide some bases for non-commutative field theories and induces us to look for further development of the classical analysis in order to provide a rigorous mathematical basis for operations with functions which have both explicit and implicit dependencies.

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[5] In fact, if we put in the corespondence to the momenta their quantum-mechanical operators (of course, with the appropriate clarification $\partial \to \hat{\partial}$), we obtain again that, in general, the derivatives do *not* commute $[\frac{\hat{\partial}}{\partial x_\mu}, \frac{\hat{\partial}}{\partial x_\nu}]_- \neq 0$.

[6] The same question can be put forward when we have differentiation with respect to the coordinates too, that may have impact on the correct calculations of the problem of accelerated charge in classical electrodynamics.

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TO QUANTIZE OR NOT TO QUANTIZE GRAVITY?

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It is shown here that the Standard Model (SM) of particle physics supports the view that gravity need not be quantized. It is shown that the SM gives a consistent description of the origin of the Universe. It is suggested that the Universe came into existence when the SM symmetry was broken spontaneously. This brings out a complete and consistent model of the physical Universe in the framework of a "semiclassical quantum gravity" theory.

To quantize or not to quantize gravity, is one of the outstanding questions facing physics today. Though there is still no compelling empirical evidence supporting quantization, the current theoretical prejudice is strongly in favour of the latter possibilty. Here it shall however be shown that the most succesful model of particle physics, the so-called Standard Model (SM), supports the former view and infact gives a consistent and complete basis for the "semiclassical quantum gravity" idea of Rosenfeld [1].

As the Universe expands, it is predicted that it undergoes a series of phase transitions [2] during which the appropriate symmetry breakes down in various stages until it reaches the stage of the SM symmetry $SU(3)_c \otimes SU(2)_L \otimes U(1)_Y$. After $t \sim 10^{-10}$ seconds (at $T \sim 10^2$ GeV) the SM phase transition to $SU(3)_c \otimes U(1)_{em}$ through the Higgs Mechanism takes place.

The SM has been well studied in the laboratory. It is the best tested model of particle physics [3]. It was however believed earlier that a weaknesses of the SM was that the electric charge was not quantized in it. However, it was as late as 1990 that this was shown to be wrong. Against all expectations, the electric charge was shown to be fully and consistently quantized in the SM [4].

It was shown by the author [4,5] that in SM $SU(N_C) \otimes SU(2)_L \times U(1)_Y$ for $N_C = 3$, spontaneous symmetry breaking by a Higgs isospin doublet of weak hypercharge Y_ϕ, the isospin -1/2 component develops the vacuum expectation value $< \phi >_0$. This fixes 'b' in the electric charge definition $Q = T_3 + bY$ to give

$$Q = T_3 + \frac{1}{2Y_\phi}Y, \tag{1}$$

where Y is the hypercharge for doublets and singlets for a single generation. For each generation renormalizability through triangular anomaly cancellation and the requirement of the identity of L- and R-handed charges in $U(1)_{em}$ one finds that all unknown hypercharges are proportional to Y_ϕ. Hence correct charges (for $N_C = 3$) fall through as below [4-8]

$$Q(u) = \frac{1}{2}(1 + \frac{1}{N_C}), \tag{2}$$

$$Q(d) = \frac{1}{2}(-1 + \frac{1}{N_C}), \tag{3}$$

$$Q(e) = -1, \tag{4}$$

$$Q(\nu) = 0. \tag{5}$$

Hence the electric charge is quantized in SM. The complete structure of the SM as is, is required to obtain this result on very general grounds.

Clearly the $U(1)_{em}$ symmetry which arose due to spontaneous symmetry breaking due to a Higgs doublet in the SM symmetry will be lost above T_c^{SM} whence $SU(2)_L \otimes U(1)_{em}$ symmetry would be restored. As is obvious, above T_c^{SM} all the fermions and gauge bosons becomes massless. Here I point out a new phenomenon arising from the restoring of the full SM symmetry .

Note that to start with the parameter b and Y in the definition of electric charge were completely unknown. We could lay a handle on 'b' entirely on the basis of the presence of spontaneous symmetry breaking and on ensuring that photon was massless $b = \frac{1}{2Y_\phi}$. Above T_c^{SM} where the SM symmetry is restored there is no spontaneous symmetry breaking and hence the parameter b is completely undetermined. Together 'bY' could be any arbitrary number whatsoever even an irrational number. Within the framework of this model above T_c^{SM} we just cannot define electric charges at all. Hence the electric charge loses any physical meaning all together. There is no such thing as charge anymore. The photon (which was a linear combination of W^0 and B_μ after spontaneous symmetry breaking), with it's defining vector characterteristic, does not exist either. So the conclusion is that there is no electrodynamics above T_c^{SM}. Maxwells equations of electrodynamics show

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that light is an electromagnetic phenomenon. Hence above the SM phase transition there was no light and no Maxwells equations. And surprisingly we are led to conclude that there was no velocity of light c as well. One knows that the velocity of light c is given as

$$c^2 = \frac{1}{\epsilon_0 \mu_0}, \tag{6}$$

where ϵ_0 and μ_0 are permittivity and permeability of the free space. These electromagnetic properties disappear along with the electric charge and hence the velocity of light also disappears above the SM phase transition.

The premise on which the theory of relativity is based is that c, the velocity of light is always the same, no matter from which frame of reference it is measured. Of fundamental significance is the invariant interval

$$s^2 = (ct)^2 - x^2 - y^2 - z^2. \tag{7}$$

Here the constant c provides us with a means of defining time in terms of spatial separation and vice versa through $l = ct$. this enables one to visualize time as the fourth dimension. Hence time gets defined due to the constant c. Therefore when there were no c as in the early Universe ,there was no time as well. As the special theory of relativity depends upon c and time, above the SM breaking scale there was no special theory of relativity. As the General Theory of relativity also requires the concept of a physical space-time, it collapses too above the SM breaking scale. Hence the whole physical Universe collapses above this scale.

Therefore it was hypothesized that the Universe came into existence when the SM symmetry was broken spontaneously [11]. Before it there was no 'time', no 'light', no maximum velocity like 'c', no gravity or space-time structure on which objective physical laws as we know it could exist [11].

In short we find that the SM of particle physics is not only good to explain all known facts, it is also capable of giving a natural and consistent description of the origin of the Universe [11].

So matter (which is quantizd) and the space-time (and so gravity) are bound together holistically. In this picture one cannot talk of matter without spacetime and neither can we talk of space-time without matter. They are two sides of the same coin and hence the Einstein's equation as per the SM should read as follows:

$$G_{\mu\nu} = 8\pi G \langle \phi | T_{\mu\nu} | \phi \rangle. \tag{8}$$

This is the "semiclassical quantum gravity" approach of Rosenfeld [1]. However here ϕ represents the complete matter degrees of freedom incorporated in the SM in terms of the three generations of matter particles plus the gauge particle of the SM (no other spurious model is needed [9,10]). Gravity, a property of the spacetime arises as a result of the quantum mechanical SM phase transtion and is not quantized. Hence as per the SM origin of the Universe scenario presented here we get a complete and consistent picture of the origin and the existence of space-time and matter. The two are inseparably connected.

It seems that the reason that inspite of rigourous efforts we have not seen graviton so far is because as shown here it does not exist. This need not shock some modern adherents of quantization of gravity as many a scientists have been warning against an urge to quantize gravity. Long ago Rosenfeld [1] had pointed out that empirical evidence and not logic forces us to quantize fields. He said that in the absence of such evidence the temptation to quantize fields must be resisted [1]. Indeed this is what the SM of particle physics is telling us. And this is within the framework of the most successful model of particle physics. Not only can the SM of particle physics provide a good description of all known particles, it also has the capacity to give a consistent picture of the origin of the Universe and also of settling the issue of whether to quantize gravity or not.

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RELATIVISTIC MOTIONS

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A physical consequence of a well - known Fermi's theorem: no motion of masses can generate gravitational waves.

1. Fermi's geometrical theorem [1] as generalized by Eisenhart [2] affirms: For a manifold endowed with a *symmetric* connection it is possible to choose a coordinate system with respect to which the components $\Gamma^i_{jk}(=\Gamma^i_{kj})$ of the connection are *zero* at *all* points of a curve (or of a portion of it).
For a Riemann - Einstein spacetime this means that there exists a coordinate system (z) with respect to which the first derivatives of the components $h_{jk}(z)$, $(j,k=0,1,2,3)$ of the metric tensor are *zero* at all points of a curve (or of a portion of it), in particular at all points of a time - like world line.

2. Let us now consider a *continuous medium* (for instance, a perfect fluid) characterized by a certain mass tensor T_{jk}, $(j,k=0,1,2,3)$, and let $g_{ik}(x)$ be the solutions of Einstein equations

$$R_{jk}-\frac{1}{2}g_{jk}R=-\kappa T_{jk} \tag{1}$$

corresponding to a generic motion of our medium with respect to a given reference system $x\equiv(x^0,x^1,x^2,x^3)$. Let us suppose to follow the motion of a given *mass element* describing a certain world line L. If we refer this motion - from the initial time on - to Fermi's coordinates $z\equiv(z^0,z^1,z^2,z^3)$, the components $h_{jk}(z)$ of the metric tensor will be equal to some constants for *all* points of line L. This means that the gravitational field *on* L has been obliterated. Consequently, no gravitational wave has been sent forth. Now, line L is quite generic, and therefore *no motion of the continuous medium can give origin to a gravitational radiation.* The absence of a "mechanism" apt to generate gravitational waves can be proved also by other arguments ([3], [4], [5], [6]). In paper [5] I have emphasized, in particular, that any particle of an incoherent "cloud of dust", characterized by a mass tensor

$$T^{jk}=\rho\frac{dx^j}{ds}\frac{dx^k}{ds},\quad (j,k=0,1,2,3), \tag{2}$$

(where ρ is the invariant mass density), describes a *geodesic* line: accordingly, it cannot emit gravitational waves. A simple application: the gravitational motions of the members of solar system.

In paper [6] I have given a very simple argument according to which no motion (gravitational or non - gravitational) of a mass point can produce gravitational waves. (The restriction of all the above arguments to the motions of point masses is clearly inessential from the conceptual point of view). Of course, the above results destroy the current conviction of the real existence of the gravitational waves [7].

"*E sarà mia colpa se così è?*"

Machiavelli

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QUANTUM GRAVITY AND GENERAL RELATIVITY CONSISTENT WITH A DECREASING SPEED OF LIGHT AND MACH'S PRINCIPLE

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Interpreting gravity as the effect of the emission of quanta of negative mass we prove that any gravitational mass increases linearly with cosmological time. The preservation of Einstein's field equations as derived from the Action Principle forces the speed of light to decrease with cosmological time, a result consistent with the conservation of momentum. We then prove that Mach's Principle has the same form as the Equivalence Principle and therefore is included in these field equations.
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1. Introduction

Relativity is a field of wide interest for the specialist as well as the general public. Recent work on the possibility of a time varying speed of light raises many questions on the validity of Einstein's Relativity Theory. Here we prove that there is a way to have a time varying speed of light that keeps intact Einstein's Special and General relativity. The point is that this time variation comes from the interpretation of gravity as a result of the emission of quanta, an interpretation very different from the classical geometrical one attributed to General Relativity. But General Relativity and Quantum Mechanics must meet in some way and here we present a theory in this direction. Emission of gravity quanta imply that the gravitational masses increase linearly with cosmological time. On the other hand we know that Mach's ideas were the source of inspiration foe Einstein in his work on relativity. Many arguments for and against the idea that his relativity includes Mach's Principle have been produced. Here we also prove that this Principle is certainly included when allowance is made for the masses to grow with cosmological time in a way that we call a Mass Boom. And the corresponding decrease in the speed of light is unavoidable if one wants to keep the conservation of momentum, the most unviolated principle in Nature.

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2. A theory of time varying "constants"

The scientific literature contains many articles related to quantum gravity. We have found a quantum of gravity m_g [1] given by

$$m_g = \frac{\hbar}{c^2 t}, \tag{1}$$

where η is Planck's constant, c the speed of light and t the age of the Universe. One way to justify (1) is as follows: to deal with an unlocalized quantum field of gravity we need a quantum of gravity with momentum $m_g c$ and an uncertainty in position of the order of the size of the seeable Universe ct, i.e.

$$m_g c \cdot ct \approx \hbar \tag{2}$$

and this is what we found [1]. The emission of such a quantum of gravity (with negative energy) from a fundamental particle of mass m gives a rate of change of mass as

$$\frac{dm}{dt} \approx \frac{m}{\tau}, \tag{3}$$

where τ is the time it takes light to travel the size of the particle, the Compton wavelength η/mc. Then from (1) and (3) we get

$$\frac{dm}{dt} \approx \frac{\hbar}{c^2 t} \cdot \frac{mc^2}{\hbar} \approx \frac{m}{t}. \tag{4}$$

Integrating the above we get a time dependence for the mass m:

$$m = At, \tag{5}$$

where A is a constant. This is what we called the Mass Boom as presented elsewhere [2]. Any mass in the Universe that manifest gravity must emit gravity quanta and increase its mass linearly with time. And General Relativity must hold even under this view that is far from the classical geometrical one. To substantiate this assertion let us find the conditions for the validity of Einsteins equations of General Relativity under the new approach of time-varying "constants". One can apply the principle of stationary action to the total action I (including a purely gravitational term I_G, [3]) as follows:

$$I = I_G + I_M,$$

$$I = -\frac{c^3}{16\pi G}\int R(x)\,(g(x))^{1/2}\,d^4x + I_M \tag{6}$$

while the action for a material free particle of mass m is

$$I_m = -mc\int ds. \tag{7}$$

We can think of time-varying "constants" (G, c, m) keeping General Relativity's equations intact if one keeps constant the coefficients in front of the integrals in (6) and (7), i.e.

$$\frac{c^3}{G} = \text{const (mass} - \text{rate)},$$

$$mc = \text{const (momentum)}. \tag{8}$$

Hence the Mass Boom giving a linear relation of mass with cosmological time in (5) implies a speed of light c decreasing with time as $1/t$, as well as a gravitational constant G decreasing with time. The constancy of mc is a manifestation of the newtonean condition of conservation of momentum. Hence any speed v will vary in the same way as c and the ratio v/c will be constant, thus keeping safe Special Relativity. Now, any experiment in the solar system trying to measure time variations in G will give a null result: orbital dynamics gives

$$v^2 = \frac{GM}{r},$$

$$mvr = \text{const}, \tag{9}$$

where M is the central body and m the orbiting one in a near circular orbit. Hence combining one has

$$GMm^2r = \text{const}, \tag{10}$$

which is the relation applied in the ranging experiments. The conditions for preserving General Relativity in (8) imply

$$\begin{aligned} &GMm^2 = \text{const},\\ &r = \text{const}. \end{aligned} \tag{11}$$

as observed. No time variations will be observed with these experiments.

Finally, interpreting Mach's Principle by saying that the rest energy og any mass m is given by its gravitational potential with respect to the rest of the Universe of mass M_u i.e.

$$\frac{GM_u m}{ct} = mc^2 \tag{12}$$

that is equivalent to

$$\frac{GM_u}{c^3} = t \tag{13}$$

implies from (8) in a certain system of units

$$\begin{aligned} &\tfrac{G}{c^3} = \text{const},\\ &M_u = t. \end{aligned} \tag{14}$$

These relations preserve General Relativity that therefore is consistent with a Mass Boom and a decreasing speed of light. This theory includes Mach's Principle in the for we have stated it. In fact this principle is a form of Einstein's Equivalence Principle, the basis for General Relativity: if the ratio v/c must be constant to get the General Relativity predictions intact, then using the gravitational orbital speed $v^2 = GM/r$ one has the condition

$$\frac{GM}{ct}\cdot\frac{1}{c^2} = \text{const}, \tag{15}$$

which is Mach's Principle as stated in (12).

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THE UNITED THEORY OF THE TWO FIELDS OF THE ELECTRIC AND MAGNETIC NATURE

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Each of electrically charged particles testifies in favor of the existence of a kind of the magnetically charged monoparticle. As a consequence, only the corresponding mononeutrinos answer for quantization of the electric charges of all the neutrinos. Therefore, to understand the nature of matter at the fundamental level one must use the electromagnetic field as the field of the unified system of the photon and monophoton where the electric and magnetic forces of the nature are united. Some logical and laboratory confirmations of the availability of compound structure of gauge invariance have been listed which say also about the connection between the states of elementary particles and monoparticles.

A study of the behavior of electrons and their neutrinos in a nucleus Coulomb field shows clearly that between the mass of a particle and its charge there exists a sharp dependence [1]. For the light Dirac neutrino ($\nu = \nu_e$) it has the form [2]

$$e_\nu^E = -\frac{3eG_F(m_\nu^E)^2}{4\pi^2\sqrt{2}}, \quad e = |e|. \tag{1}$$

Here m_ν^E and e_ν^E are the neutrino electric rest mass and charge.

Such an intimate connection saying about the gravitational structure of a Coulomb interaction and reflects the fact that the mass and charge of a particle correspond to the most diverse form of the same regularity of the nature of this field [2, 3].

On the other hand, it is known that in the framework of the hypothesis of field mass based on the classical theory of an extensive electron [4], a particle all the mass is purely electric. However, according to such a point of view, the charge distribution of the neutrino will not be steady.

Our conclusion is that each of existing types of charges come forwards in the system as the source of a kind of the inertial mass [5]. Herewith all the mass of the neutrino coincides with its united rest mass m_ν^U which includes in self the electric m_ν^E, weak m_ν^W, strong m_ν^S and some other components:

$$m_\nu^U = m_\nu^E + m_\nu^W + m_\nu^S + \ldots. \tag{2}$$

Such a compound structure giving the possibility to directly look at the nature of matter is observed as a consequence of the availability of the united charge e_ν^U in neutrino equal to its all the charge [5]:

$$e_\nu^U = e_\nu^E + e_\nu^W + e_\nu^S + \ldots, \tag{3}$$

where the indices E, W and S correspond to the electric, weak and strong parts of charge.

Thus, it follows that if the neutrino possesses a Dirac mass then all possible components of this mass establish the intraneutrino interratio between the forces of the electric and unelectric nature. Therefore, the charge distribution of the neutrino must be steady [6].

The purpose of the present article is to elucidate what the above - mentioned duality of matter say about structures of electromagnetic field, gauge invariance and charge quantization law.

In the framework of the loop phenomena, the neutrino must be electrically neutral at the conservation of gauge invariance [7]. It appears that here on the basis of (1) one can will decide a question about the equality of the neutrino electric mass to zero.

But if $m_\nu^E = 0$, the neutrino is strictly Majorana particle [5]. At the same time the existence of massive Dirac neutrinos is by no means excluded experimentally. Insofar as their neutrality in the loop approximation is concerned, it reflects just a latent regularity of general picture of gauge invariance which requires the study of the structure of electromagnetic field.

At first sight it appears that a connection between e_ν^E and m_ν^E is incompatible with charge quantization. Such a regularity, however, takes place owing to the magnetic monopoles. It is also known that the standard $SU(2)_L \otimes U(1)$ theory, by itself, does not require [8] that the magnetic monopoles be exist in the form as was suggested by Dirac [9]. Therefore, from point of

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view of a massive four - component neutrino, it should be expected that each of electrically charged particles testifies in favor of the existence of a kind of a ¡monoparticle¿ namely a particle having the magnetic mass and charge. Then it is possible, for example, only the corresponding mononeutrinos are responsible for quantization of the electric charges of all the neutrinos.

There exists a range of other phenomena, in which a fundamental part is said of monoparticles. One of such systems may serve as the source of electromagnetic field. But unlike earlier known, it must not be usual gauge boson. The point is that the same photon does not lead to the appearance of electromagnetic field. It possesses the electric mass [10] and charge [11].

From point of view of a Dirac neutrino, this gauge state will indicate to the existence of the monophoton with the magnetic mass and charge. In other words, the photon γ_E and monophoton γ_H must be source of the electric $\vec{E}$ and magnetic $\vec{H}$ fields respectively. Under shuch circumstances the electromagnetic field $(\vec{E}, \vec{H})$ appears as the field of the unified system of the photon and monophoton (γ_E, γ_H) where the electric $\vec{F}_E$ and magnetic $\vec{F}_H$ forces of the nature are united.

To elucidate the compound structure of its gauge invariance one must apply once more to the question whether the same particle has simultaneously both electric and magnetic charges. There exist, however, many uncertainties both in the nature and in the behavior of these types of charges. Nevertheless, if we assume [12] that the possibility of the existence of such Dirac fermions is not excluded, the neutrino interaction with an electromagnetic field of emission arises at the expense of exchange simultaneously both by the photon and by the monophoton. The latter would lead us to the implication that the invariance of these types of gauge bosons concerning C, P and T, and also their combinations CP and CPT are not different.

Finally, insofar as the appearance of magnetic field in usual laboratory conditions is concerned, to this one must apply as to one of the available experimental data confirming the existence of monoparticles and saying that any electrically charged particle can be converted into the corresponding monoparticle and vice versa. Of course, these transitions and many other aspects of compound structure of each of existing types of charges and masses open of principle possibilities for creation at the fundamental level of truly physical theories of naturally united gauge fields.

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ON THE TYPE OF THE SPIN POLARIZATION DEPENDENCE OF THE NEUTRINO MASS AND CHARGE

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Any non-zero component of charge implies the existence of a kind of the inertial mass. Therefore, each of existing types of the dipole moments must arise as a consequence of the availability of a kind of charge. From their point of view, the elastic scattering of completely longitudinal and transversal polarized neutrinos (antineutrinos) by spinless nuclei is discussed taking into account the united rest mass and charge, and also the magnetic, anapole and electric dipole moments of incoming fermions with neutral currents. Interconversions of neutrinos of the different components have been investigated, at which a particle chiral invariance is violated at the expense of the flip of its spin. This becomes possible owing to an intimate connection between these phenomena and character of the structure of a Dirac mass. Analysis of the studied processes cross sections assumed that both masses and charges of longitudinal and transversal neutrinos are strictly unidentical.

1. Introduction

In studying the nature of elementary particles such characteristics as the mass and charge play a large role. At the same time it is well known that according to the hypothesis of field mass based on the classical theory of an extensive electron [1], a particle all the mass is purely electric. Such a structure, however, meets with many problems. One of them states that the charge distribution of the electron is not steady.

My investigation of the interaction of electrons and their neutrinos with field of emission shows clearly [2, 3] that if the neutrino corresponds to the electron ($\nu = \nu_e$), its full electric charge e_ν^{full} and magnetic moment μ_ν^{full} appear owing to the Coulomb mass m_ν^E and behave as [4]

$$e_\nu^{full} = -\frac{3eG_F m_\nu^2}{4\pi^2\sqrt{2}}, \quad e = |e|, \tag{1}$$

$$\mu_\nu^{full} = \frac{3eG_F m_\nu}{8\pi^2\sqrt{2}}, \quad m_\nu = m_\nu^E. \tag{2}$$

This picture reflects the fact that each of available types of charges say in favor of the availability of a kind of the inertial mass. Thereby the possiblity of the existence of the united rest mass m_ν^U and charge e_ν^U for the neutrino equal respectively to its all the mass and charge is not excluded. One can define their structures in the form [5]

$$m_\nu^U = m_\nu^E + m_\nu^W + m_\nu^S + ..., \tag{3}$$

$$e_\nu^U = e_\nu^E + e_\nu^W + e_\nu^S + ... \tag{4}$$

Here the indices E, W and S correspond to the electric, weak and strong components of the neutrino mass and charge. They constitute herewith the harmony of forces of the different nature. Therefore, the charges distributions of light leptons must be steady [6].

Such a stability of matter saying about the compound structure of charge quantization law [7] and testifies of that any non - zero component of the electric charge implies the existence of a kind of the dipole moment. In other words, the Dirac $F_{1\nu}(q^2)$ and the Pauli $F_{2\nu}(q^2)$ form factors contain the statical as well as the dynamical components [6]:

$$F_{i\nu}(q^2) = f_{i\nu}(0) + A_{i\nu}(\vec{q^2}) + ..., \tag{5}$$

where $f_{i\nu}(0)$ give the normal size of charge and moment, $A_{i\nu}(\vec{q^2})$ characterize the momentum dependence of leptonic current vector parts. The terms $f_{i\nu}(0)$ and $A_{i\nu}(\vec{q^2})$ are responsible for the first and the second Born approximations. In these circumstances, the form factors $F_{1\nu}(q^2)$ and $F_{2\nu}(q^2)$ at $q^2 = 0$ define the full static values of the neutrino electric charge and moment:

$$F_{1\nu}(0) = e_\nu^{full} = e_\nu^{norm} + e_\nu^{anom} + ..., \tag{6}$$

$$F_{2\nu}(0) = \mu_\nu^{full} = \mu_\nu^{norm} + \mu_\nu^{anom} + ... \tag{7}$$

Of course the electric mass and charge of a Dirac neutrino correspond to the most diverse form of the same regularity of its Coulomb nature. By this reason

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we conclude that the neutrino electric mass m_ν^E includes in self as well as the normal m_ν^{norm} and anomalous m_ν^{anom} components [4]:

$$m_\nu^E = m_\nu^{norm} + m_\nu^{anom} + ... \quad (8)$$

However, it is known [8, 9] that the neutrino interaction with virtual photon is described by the vertex operator

$$\Gamma_\mu(p,p') = \overline{u}(p',s')[\gamma_\mu F_{1\nu}(q^2) - i\sigma_{\mu\lambda}q_\lambda F_{2\nu}(q^2) + \\ +\gamma_5\gamma_\mu G_{1\nu}(q^2) - i\gamma_5\sigma_{\mu\lambda}q_\lambda G_{2\nu}(q^2)]u(p,s). \quad (9)$$

Here $\sigma_{\mu\lambda} = [\gamma_\mu, \gamma_\lambda]/2$, $q = p - p'$, $p(s)$ and $p'(s')$ denote the four - momentum (helicity) of the neutrino before and after emission, $G_{1\nu}(q^2)$ and $G_{2\nu}(q^2)$ are the leptonic current axial - vector parts.

Analysis of electroweak processes on nuclei assumed [10] that $F_{2\nu}$ and $G_{2\nu}$ must have the same size. Therefore, without loss of generality, we may write

$$G_{i\nu}(q^2) = g_{i\nu}(0) + \Phi_{i\nu}(\vec{q^2}) + ..., \quad (10)$$

where $g_{1\nu}(0)$ and $g_{2\nu}(0)$ are the normal components of a particle anapole [11] and electric dipole moments. The functions $\Phi_{i\nu}(\vec{q^2})$ characterize the anomalous behavior of axial - vector form factors.

According to the correspondence principle, each term in (10) as well as in (5), corresponds to the definite approximation. This sight to the interaction axial - vector nature quality explains the fact that $G_{1\nu}(0)$ and $G_{2\nu}(0)$ give the full static size of a Dirac particle anapole and electric dipole moments:

$$G_{1\nu}(0) = a_\nu^{full} = a_\nu^{norm} + a_\nu^{anom} + ..., \quad (11)$$

$$G_{2\nu}(0) = d_\nu^{full} = d_\nu^{norm} + d_\nu^{anom} + ... \quad (12)$$

Of them a_ν^{full} also can be measured experimentally [12]. For d_ν^{full} as well as for e_ν^{full} and μ_ν^{full} there exist laboratory and cosmological restrictions [13, 14].

The purpose of the present work is to discuss the problem of the neutrino latent mass investigating its interaction with field of electroweak emission in the polarization type dependence. First of all we consider the elastic scattering of longitudinal polarized massive Dirac neutrinos by nuclei of the electric (Z) and weak (Z_W) charges

$$\nu_{L,R}(\overline{\nu}_{R,L}) + A(Z, Z_W) \overset{\gamma, Z^0}{\to} \nu'(\overline{\nu'}) + A(Z, Z_W) \quad (13)$$

at the account of their earlier known and new properties. Next, all they will be reanalysed for the transversal case of incoming particles polarizations. In conclusion we present some implications implied from these considerations.

2. Interaction of Longitudinal Polarized Neutrinos with Field of a Nucleus

From our earlier developments, we find that the matrix elements of elastic scattering of an arbitrary polarized neutrinos on the nucleus electric and weak charges in the first Born approximation must have the following structures:

$$M_{fi}^E = \frac{4\pi\alpha}{q_E^2}\overline{u}(p'_E, s')[\gamma_\mu f_{1\nu}(0) - i\sigma_{\mu\lambda}q_E^\lambda f_{2\nu}(0) + \\ +\gamma_5\gamma_\mu g_{1\nu}(0) - i\gamma_5\sigma_{\mu\lambda}q_E^\lambda g_{2\nu}(0)]u(p_E, s)J_\mu^\gamma(q_E), \quad (14)$$

$$M_{fi}^W = \frac{G_F}{\sqrt{2}}\overline{u}(p'_W, s')\gamma_\mu(g_{V_\nu} + \gamma_5 g_{A_\nu})x \\ x\,u(p_W, s)J_\mu^{Z^0}(q_W). \quad (15)$$

Here $\nu = \nu_{L,R} = \nu_{eL,R}$, $q_E = p_E - p'_E$, $q_W = p_W - p'_W$, $p_E(p_W)$ and $p'_E(p'_W)$ imply the four - momentum of the neutrino before and after the electric (weak) emission, J_μ^x are the nuclear charged $(x = \gamma)$ and neutral $(x = Z^0)$ currents [15], g_{V_ν} and g_{A_ν} denote the corresponding constants of purely weak interaction vector and axial - vector components.

As seen from (14) and (15), in the case of exchange by the photon, only the Coulomb mass is responsible for the electric scattering. Insofar as m_ν^W is concerned, it leads to the corresponding weak interaction.

It appears that here on the basis of the standard definition

$$\frac{d\sigma_{EW}(s,s')}{d\Omega} = \frac{1}{16\pi^2}|M_{fi}^E + M_{fi}^W|^2 \quad (16)$$

one can will establish an explicit form of the studied processes cross sections. It is not excluded, however, that any Dirac particle possesses simultaneously both electric and weak masses. In other words, the neutrino interaction with field of emission explained by the electroweak interference arises at the expense of exchange simultaneously both by the photon and by the weak boson. From this point of view, the interference between the interactions (14) and (15) can be expressed as follows:

$$2ReM_{fi}^E M_{fi}^{*W} = \frac{8\pi\alpha G_F}{\sqrt{2}q_{EW}^2}Re\,\rho_{EW}\rho'_{EW}[\gamma_\mu f_{1\nu}(0) - \\ -i\sigma_{\mu\lambda}q_{EW}^\lambda f_{2\nu}(0) + \gamma_5\gamma_\mu g_{1\nu}(0) - \\ -i\gamma_5\sigma_{\mu\lambda}q_{EW}^\lambda g_{2\nu}(0)]\gamma_\mu(g_{V_\nu} + \gamma_5 g_{A_\nu})x \\ x\,J_\mu^\gamma(q_{EW})J_\mu^{Z^0}(q_{EW}). \quad (17)$$

Here and further it is necessary to keep in mind that

$$q_{EW} = p_{EW} - p'_{EW}, \quad m_\nu^{EW} = m_\nu^E + m_\nu^W,$$

$$\rho_{EW} = u(p_{EW}, s)\overline{u}(p_{EW}, s),$$

$$\rho'_{EW} = u(p'_{EW}, s')\overline{u}(p'_{EW}, s').$$

According to these data, the general form of the cross section of the process (13) at the account of longitudinal polarizations of both incoming and outgoing fermions is written in the form

$$d\sigma_{EW}^{V,A}(\theta, s, s') = d\sigma_{E}^{V,A}(\theta, s, s') + \\ + d\sigma_{I}^{V,A}(\theta, s, s') + d\sigma_{W}^{V,A}(\theta, s, s'), \quad (18)$$

where the contribution of purely electric mass has the size

$$\frac{d\sigma_{E}^{V,A}(\theta, s, s')}{d\Omega} = \frac{1}{2}\sigma_o^{\nu}(1-\eta_E^2)^{-1}\{(1+ss')[f_{1\nu}+ \\ +2\lambda_c s\sqrt{1-\eta_E^2}g_{1\nu}]f_{1\nu}+ \\ +\eta_E^2(1-ss')[f_{1\nu}^2+4(m_\nu^E)^2(1-\eta_E^{-2})^2 f_{2\nu}^2]tg^2\frac{\theta}{2}- \\ -8s(E_\nu^E)^2(1-ss')(1-\eta_E^2)^{3/2}f_{2\nu}g_{2\nu}tg^2\frac{\theta}{2}+ \\ +(1-\eta_E^2)[(1+ss')g_{1\nu}^2+ \\ +4(E_\nu^E)^2(1-ss')g_{2\nu}^2 tg^2\frac{\theta}{2}]\}F_E^2(q_E^2). \quad (19)$$

The second term characterize the interference of the electric and weak interactions as a consequence of the availability of the united electroweak rest mass of incoming particles:

$$\frac{d\sigma_{I}^{V,A}(\theta, s, s')}{d\Omega} = \frac{1}{2}\rho\sigma_o^{\nu}(1-\eta_{EW}^2)^{-1}g_{V_\nu}\{(1+ss')[1- \\ -\lambda_c s\frac{g_{A_\nu}}{g_{V_\nu}}\sqrt{1-\eta_{EW}^2}][f_{1\nu}+\lambda_c s\sqrt{1-\eta_{EW}^2}g_{1\nu}]+ \\ +\eta_{EW}^2(1-ss')f_{1\nu}tg^2\frac{\theta}{2}\}F_{EW}(q_{EW}^2). \quad (20)$$

The corresponding cross section for the process going at the expense of the neutrino purely weak rest mass behaves as

$$\frac{d\sigma_{W}^{V,A}(\theta, s, s')}{d\Omega} = \frac{G_F^2(E_\nu^W)^2}{16\pi^2}\{g_{V_\nu}^2[(1+ss')cos^2\frac{\theta}{2}+ \\ +\eta_W^2(1-ss')sin^2\frac{\theta}{2}]+g_{A_\nu}^2(1-ss')(1-\eta_W^2)cos^2\frac{\theta}{2}- \\ -2\lambda_c s g_{V_\nu}g_{A_\nu}(1+ss')\sqrt{1-\eta_W^2}cos^2\frac{\theta}{2}\}F_W^2(q_W^2). \quad (21)$$

Here we must have in view of that

$$\sigma_o^{\nu} = \frac{\alpha^2 cos^2\frac{\theta}{2}}{4(E_\nu^E)^2(1-\eta_E^2)sin^4\frac{\theta}{2}}, \quad \rho = \frac{q_E^2}{q_{EW}^2}\frac{G_F}{2\pi\sqrt{2}\alpha},$$

$$\eta_E = \frac{m_\nu^E}{E_\nu^E}, \quad \eta_{EW} = \frac{m_\nu^{EW}}{E_\nu^{EW}}, \quad \eta_W = \frac{m_\nu^W}{E_\nu^W},$$

$$F_E(q_E^2) = ZF_c(q_E^2), \quad F_{EW}(q_{EW}^2) = ZZ_W F_c^2(q_{EW}^2),$$

$$F_W(q_W^2) = Z_W F_c(q_W^2), \quad A = Z+N,$$

$$Z_W = \frac{1}{2}\{\beta_V^{(0)}(Z+N)+\beta_V^{(1)}(Z-N)\}, \; M_T = \frac{1}{2}(Z-N),$$

where θ is the polar angle, E_ν^E, E_ν^{EW} and E_ν^W are the neutrinos energies at the elastic electric, electroweak and weak scattering, $F_c(q_E^2)$, $F_c(q_{EW}^2)$ and $F_c(q_W^2)$ denote the charge ($F_c(0)=1$) form factors of a nucleus in these three processes, M_T is the projection of its isospin T, and constants $\beta_V^{(0)}$ and $\beta_V^{(1)}$ correspond to the isoscalar and isovector components of the nuclear vector neutral current.

The indices V and A imply the simultaneous presence of both vector and axial - vector parts of charged and neutral leptonic currents. Therefore, any of the expressions (19) - (21) for the neutrino ($\lambda_c = +1$) and the antineutrino ($\lambda_c = -1$) is different which becomes possible owing to the interference of the interaction vector and axial - vector components.

The terms $(1+ss')$ and $(1-ss')$ characterize the scattering with conservation ($s'=s$) and change ($s'=-s$) of helicities of incoming left ($s=-1$) - and right ($s=+1$) - polarized particles. Under such circumstances the value of the cross section (18) conveniently replace by the summed size

$$d\sigma_{EW}^{V,A}(\theta, s) = d\sigma_{EW}^{V,A}(\theta, s'=s)+ \\ + d\sigma_{EW}^{V,A}(\theta, s'=-s). \quad (22)$$

The compound structures of both terms of (22) testify of that the neutrino charge $f_{1\nu}$ leads to the scattering either with or without flip of its spin. The anapole $g_{1\nu}$ does not change a particle helicity. In contrast to this, the vector $f_{2\nu}$ and axial - vector $g_{2\nu}$ moments are responsible only for the flip of the neutrino spin. Of course, our formulas can also confirm the fact that the helicity of the neutrino of large energy ($E_\nu \gg m_\nu$) is not changed.

However, as known, the right - handed neutrino meets with the problem which states that does not exist a chiral symmetry characterized a massive particle. Therefore, it appears that the neutrinos have no neither the electric, weak nor any other mass. But this is not quite so. The point is that at the conservation of helicity a particle chirality is not changed even if it possesses a non - zero rest mass. In other words, the longitudinal neutrino chirality can be violated at the expense of mass, charge, magnetic and electric dipole moments, because they lead to the flip of its spin.

In the absence of one of currents V or A any of (19) - (21) not only for the particles and the antiparticles but also for the left - and right - handed neutrinos coincides. Such an equality takes place as well as in the low energies limits of the corresponding processes.

3. Transversal Polarized Neutrinos Scattering by Nuclei of Electroweak Charges

Owing to an intimate connection between the mass of a particle and its physical nature, any massive neutrino has the longitudinal as well as the transversal polarization. Here an important circumstance is the fact that the same neutrino must not be simultaneously both longitudinal and transversal fermions. There exists, however, the possibility that the longitudinal polarized neutrinos in the elastic scattering on a nucleus can be converted into the transversal polarized and vice versa [16].

Returning to (14) - (17), for the transversal case of the neutrino polarization we establish the compound structure of the cross section of the process (13) which one can present as follows:

$$d\sigma_{EW}^{V,A}(\theta,\varphi,s,s') = d\sigma_{E}^{V,A}(\theta,\varphi,s,s') + \\ + d\sigma_{I}^{V,A}(\theta,\varphi,s,s') + d\sigma_{W}^{V,A}(\theta,\varphi,s,s'). \qquad (23)$$

Here to the contribution of purely electric mass answers the expression

$$\frac{d\sigma_{E}^{V,A}(\theta,\varphi,s,s')}{d\Omega} = \frac{1}{2}\sigma_o^{\nu}(1-\eta_E^2)^{-1}\{((1+ \\ +ss')\alpha_T cos^2\frac{\varphi}{2} + (1-ss')\alpha_T^* sin^2\frac{\varphi}{2})f_{1\nu}^2 + \\ +\eta_E^2((1+ss')\gamma_T sin^2\frac{\varphi}{2} - \\ -(1-ss')\gamma_T^* cos^2\frac{\varphi}{2})[f_{1\nu}^2 + \\ +4(m_\nu^E)^2(1-\eta_E^{-2})^2 f_{2\nu}^2]tg^2\frac{\theta}{2} + \\ +2\lambda_c s\eta_E\sqrt{1-\eta_E^2}((1+ss')sin^2\frac{\varphi}{2} - \\ -(1-ss')cos^2\frac{\varphi}{2})\gamma_T^* f_{1\nu}g_{1\nu}tg\frac{\theta}{2} + \\ +(1-\eta_E^2)((1+ss')\alpha_T^* sin^2\frac{\varphi}{2} + \\ +(1-ss')\alpha_T cos^2\frac{\varphi}{2})g_{1\nu}^2 + \\ +4(E_\nu^E)^2(1-\eta_E^2)((1+ss')\gamma_T^* cos^2\frac{\varphi}{2} - \\ -(1-ss')\gamma_T sin^2\frac{\varphi}{2})g_{2\nu}^2 tg^2\frac{\theta}{2}\}F_E^2(q_E^2). \qquad (24)$$

The cross section of the interference process originated at the expense of the united electroweak rest mass of incoming transversal polarized neutrinos has the following structure:

$$\frac{d\sigma_{I}^{V,A}(\theta,\varphi,s,s')}{d\Omega} = \frac{1}{2}\rho\sigma_o^{\nu}(1-\eta_{EW}^2)^{-1}g_{V_\nu}\{((1+ \\ +ss')\alpha_T cos^2\frac{\varphi}{2} + +(1-ss')\alpha_T^* sin^2\frac{\varphi}{2})f_{1\nu} + \\ +\eta_{EW}^2[((1+ss')\gamma_T sin^2\frac{\varphi}{2} - (1-ss')\gamma_T^* cos^2\frac{\varphi}{2})tg\frac{\theta}{2} + \\ +\lambda_c s\frac{g_{A_\nu}}{g_{V_\nu}}\eta_{EW}^{-1}\sqrt{1-\eta_{EW}^2}((1+ss')sin^2\frac{\varphi}{2} - \\ -(1-ss')cos^2\frac{\varphi}{2})\gamma_T^*]f_{1\nu}tg\frac{\theta}{2} - \\ -\lambda_c s\eta_{EW}\sqrt{1-\eta_{EW}^2}[((1+ss')sin^2\frac{\varphi}{2} - \\ -(1-ss')cos^2\frac{\varphi}{2})\gamma_T^* tg\frac{\theta}{2} + \\ +\lambda_c s\frac{g_{A_\nu}}{g_{V_\nu}}\eta_{EW}^{-1}\sqrt{1-\eta_{EW}^2}((1+ss')\alpha_T^* sin^2\frac{\varphi}{2} + \\ +(1-ss')\alpha_T cos^2\frac{\varphi}{2})]g_{1\nu}\}F_{EW}(q_{EW}^2). \qquad (25)$$

The contribution explained by the transversal polarized neutrinos purely weak rest mass is written in the form

$$\frac{d\sigma_{W}^{V,A}(\theta,\varphi,s,s')}{d\Omega} = \frac{G_F^2(E_\nu^W)^2}{16\pi^2}\{g_{V_\nu}^2[((1+ \\ +ss')\alpha_T cos^2\frac{\varphi}{2} + (1-ss')\alpha_T^* sin^2\frac{\varphi}{2})ctg^2\frac{\theta}{2} + \\ +\eta_W^2((1+ss')\gamma_T sin^2\frac{\varphi}{2} - (1-ss')\gamma_T^* cos^2\frac{\varphi}{2})]sin^2\frac{\theta}{2} + \\ +g_{A_\nu}^2(1-\eta_W^2)((1+ss')\alpha_T^* sin^2\frac{\varphi}{2} + \\ +(1-ss')\alpha_T cos^2\frac{\varphi}{2})cos^2\frac{\theta}{2} - \\ -2\lambda_c s g_{V_\nu}g_{A_\nu}\eta_W\sqrt{1-\eta_W^2}((1+ss')sin^2\frac{\varphi}{2} - \\ -(1-ss')cos^2\frac{\varphi}{2})\gamma_T^* sin\frac{\theta}{2}cos\frac{\theta}{2}\}F_W^2(q_W^2), \qquad (26)$$

where it has been accepted that

$$\alpha_T = 1 - 2(1-4sin^2\frac{\varphi}{2})sin^2\frac{\varphi}{2},$$

$$\alpha_T^* = 1 + 2(1-4sin^2\frac{\varphi}{2})cos^2\frac{\varphi}{2},$$

$$\gamma_T = 1 + 2cos^2\frac{\varphi}{2}, \quad \gamma_T^* = 1 - 2cos^2\frac{\varphi}{2}.$$

Here φ is the azimuthal angle.

As well as in (18), each term in (23) contains the contributions of vector and axial - vector interactions, and also the contributions of their interference between themselves owing to which, the neutrino and the antineutrino scattering cross sections are different.

Furthermore, if taken into account the availability of the multiplier $(1+ss')$ and $(1-ss')$ in (24) - (26), we can present (23) in the form

$$d\sigma_{EW}^{V,A}(\theta,\varphi,s) = d\sigma_{EW}^{V,A}(\theta,\varphi,s'=s)+ \\ +d\sigma_{EW}^{V,A}(\theta,\varphi,s'=-s). \quad (27)$$

An explicit expressions for both terms of (27) have the most diverse structures. From their point of view, in the case of the neutrino transversal polarization, the processes with or without change of incoming particles helicities must go as a consequence not only of charge but also of any dipole moment. It is of course not excluded that the flip of the transversal neutrino spin which arises at the expense of mass, charge, magnetic, anapole and electric dipole moments can explain the possible violation of its chirality.

The absence of one of currents V or A implies that each of (24) - (26) for the neutrino and the antineutrino as well as for the left - and right - handed particles is not different. Such a coincidence takes place even in the low energies limits of the corresponding types of interactions.

4. Conclusion

In conformity with laws of the nature of a massive neutrino, the presence of any type charge implies the existence of a kind of the inertial mass [5]. Such a duality of matter saying about the steadity of charge distribution of the neutrino and testifies of that each of all possible types of the dipole moments arises as a consequence of the availability of a kind of charge [6]. Therefore, to reanalyse these features and discuss their some implications we have established the compound structures of the differential cross sections described the elastic scattering of completely longitudinal and transversal polarized neutrinos (antineutrinos) by spinless nuclei taking into account the united rest mass and charge, and also the magnetic, anapole and electric dipole moments of incoming fermions with neutral currents.

They state that if neutrinos are of longitudinal polarized, their charge answers to the elastic scattering either with or without flip of the spin. The anapole is responsible only for the conservation of a particle helicity. Unlike this, both magnetic and electric dipole moments lead to the interconversions of neutrinos of the different components. However, in the transversal case of the neutrino polarization, each of these processes can originate through the interactions of charge as well as of any dipole moment with field of emission.

The exitence of interconversions $\nu_L \leftrightarrow \nu_R$ and $\overline{\nu}_R \leftrightarrow \overline{\nu_L}$ is incompatible with chiral invariance. These transitions, however, take place owing to the rest mass dependence of the behavior of the neutrino. At our sight, this connection implies that a particle chirality is violated at the expense of the flip of its helicity.

In the case of the neutrino both longitudinl and transversal polarizations, the process (13) is described by the three differential cross sections corresponding to the electric, weak and the united electroweak parts of mass and charge. These cross sections can be defined simultaneously for the same energy, if herewith all the three momentum transfer have the space - like size.

One of the beautiful new features of our formulas is the indication to the existence of the different low energies limits for the same particle regardless of polarization type. They of course in the slow neutrino scattering by nuclei behave as

$$E_\nu^E \to m_\nu^E, \quad E_\nu^{EW} \to m_\nu^{EW}, \quad E_\nu^W \to m_\nu^W. \quad (28)$$

At these values the cross sections (22) and (27) describing respectively the processes with longitudinal and transversal fermions are not different:

$$d\sigma_{EW}^{V,A}(\theta,s) = d\sigma_{EW}^{V,A}(\theta,\varphi,s). \quad (29)$$

For an arbitrary energy such a situation takes place when be present either vector or axial - vector interactions:

$$d\sigma_{EW}^{V}(\theta,s) = d\sigma_{EW}^{V}(\theta,\varphi,s), \quad (30)$$

$$d\sigma_{EW}^{A}(\theta,s) = d\sigma_{EW}^{A}(\theta,\varphi,s). \quad (31)$$

But all the three equalities (29) - (31) there exist only at the condition that a particle rest mass does not depend on the type of polarization.

Thus, if it turns out that at the availability of a non - zero mass the longitudinal polarized neutrino must be converted into the transversal polarized and vice versa, this will indicate to the existence of fundamental differences in the masses as well as in the charges of longitudinal and transversal neutrinos.

Comparing (19) with (24), it is easy to observe the contribution of $sf_{1\nu}g_{1\nu}$ which is absent at the elastic scattering of longitudinal neutrinos on nuclei but arises as a result of their transversal polarization. The term $sf_{2\nu}g_{2\nu}$ available in the longitudinal case of the neutrino polarization does not appear at the transversal particles interaction. We can, therefore, conclude that the invariance of vector and axial - vector types of electroweak currents of longitudinal and transversal neutrinos concerning C, P and T, and also their combinations CP and CPT are different.

Finally, insofar as the spin polarization type dependence of the behavior of massive Majorana neutrinos is concerned, this question together with some aspects of the geometrical nature of the inertial mass will be treatmented in one of our further articles.

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ON THE ELECTRODYNAMICS OF SPINNING MAGNETS

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This paper deals with a crucial issue left open by Einstein in his famous 1905 paper in Annalen der Physik.

1. Homopolar Induction. Historical Scenario

"The most curious electrodynamics experiments are those where a continuous rotation takes place, called unipolar experiments". H. Poincaré [1].

"It is known that Maxwell's electrodynamics-as usually understood at the present time- when applied to moving movies, leads to asymmetries which do not appear to be inherent in the phenomena... Moreover, questions as to the seat of electrodynamic electromotive forces (unipolar machines) have no point". A. Einstein [2].

"The systen of power about the magnet must not be considered as necessarily rotating with the magnet, any more than the rays of light which emanate from the sun are suppossed to revolve with the sun". Michael Faraday [3].

"This is at variance with our transformation laws for linear motion, and it is an indication that the absolute rotational motion of the disk... can in principle be detected". W.K.H. Panofsky [4,5].

"For nearly a century after its discovery... the unipolar generator was a conundrum for the theory of electromagnetism... The most vexatious question concerned the 'seat' of the electromotive force". D.F. Bartlett [3].

"The whole problem baffled the greattest electrodynamicists of the 19th *century".* A. Miller [6].

"A warping of space which is attributted to the rotation of distant masses of the universe... shows that an 'extra current' appears and modifies the electromagnetic tensor equations", L.I. Schiff [6].

"Rotating circuits and magnets are 'hazardous' for Special Relativity". D. Webster [7].

"Kennard makes no consideration about inductions on the galvanometer. This means that he does not consider the galvanometer as a part of the seat of induction". A.K.T. Assis [8].

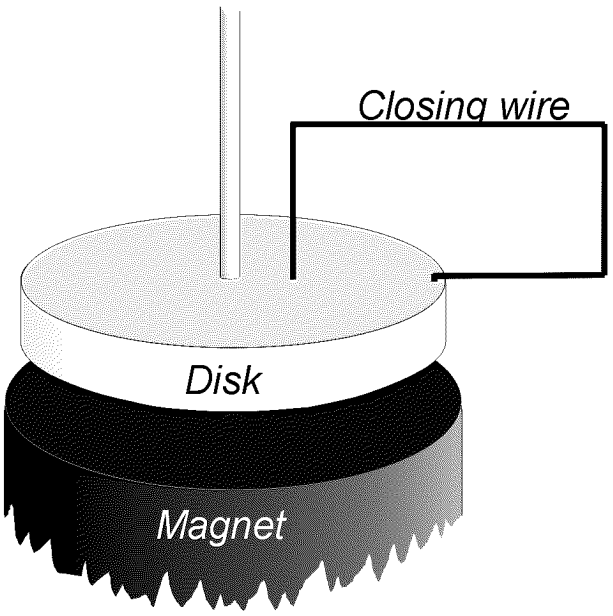

Figure 1: Faraday's Setup Magnet, Disk and Closing Wire

The essential features of the *Unipolar electromagnetic phenomena* (name coined by Weber, nowadays known as *Homopolar phenomena*) are shown in Fig. 1, which sketches the Faraday disk, the first conceived unipolar engine. A conducting disk, free to rotate in the neighborhood of a permanent magnet, is attached to a shaft. A *closing wire* provides a conducting path between two arbitrary points on the disk. Such device exhibits a *reversible* behaviour:

First case

Injecting direct current (dc) from an external source into the closing wire, its interaction with the magnetic field produces a *ponderomotive* Laplace force [9] $dF = I\,(dl \times B)$ responsible for the disk rotation in a *motor* configuration.

With the disk spun by an external source of mechanical energy, each moving charge is acted on by the

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Lorentz force $F = q\,(v \times B)$, and an *electromotive* force emf appears in the bulk of the disk, in a *generator* configuration.

Second case

A seemingly curious fact occurs when the magnet is attached to the disk. In both the above configurations the system behaves as well as if the magnet were at rest. Two rival theories, a *relativistic* and an *absolutistic* one, are customarily applied to describe *unipolar phenomena*:

Relativistic view.

A generator configuration makes sense only by the motion of the magnet relative to the conductor: the disk itself in the first case, the closing wire in the second one. In a motor configuration, what matters is the *possibility* of relative motion between the magnet an the conductor: the disk in the first case, the closing wire in the second one.

Absolutistic view.

A generator configuration is enabled only because of the *absolute* motion of the conductor: the disk in both the first and second cases. Here absolute means "relative to a frame where the preponderance of the mass of the universe is at rest" [4,5] .For the present purposes, the lab frame acts as an acceptable absolute-motion reference [10,11]. From an absolutistic view, the magnet's rotation with $\partial B/\partial t = 0$ in each point of the surrounding space is unable to produce an emf on nearby conductors [12]. The rotation observed in a motor configuration is attributed in this framework the the magnet "dragging" effect by the conductor, with the closing wire acting as a "passive" circuit element.

Experimentation performed on the original Faraday setup is not availabe to rule out none of the two above interpretations [3]. A remarkable experimental paper stressing the true relativistic nature of homopolar induction was recently published by A. Kelly [13].

2. A modified Faraday disk

Fig. 2 shows the *asymmetrical rotor*, a modified version of the original Faraday disk, in which a region of the magnet- the *singularity* from here on- was removed in order to achieve a *B-field* inversion [14,15,16,17]. Outgoing (ingoing) B vectors are represented by the $\bullet$ ($\otimes$) symbol. The magnet is embedded in a wood cylinder anchored to a vertical shaft terminated in sharp points at both ends. While the lower one lays on a hard-polished surface, the upper one is centered by a conical bearing enabling its almost frictionless rotation. The inner and outer mercury collector rings allow to close a circuit through the closing wire. Mounted on a bearing centered with the shaft is a radial *probe* wire, whose ends are in contact with the collector rings. The probe is free to rotate about the shaft.

Fig. 3 shows the *asymmetrical rotor* as applied to

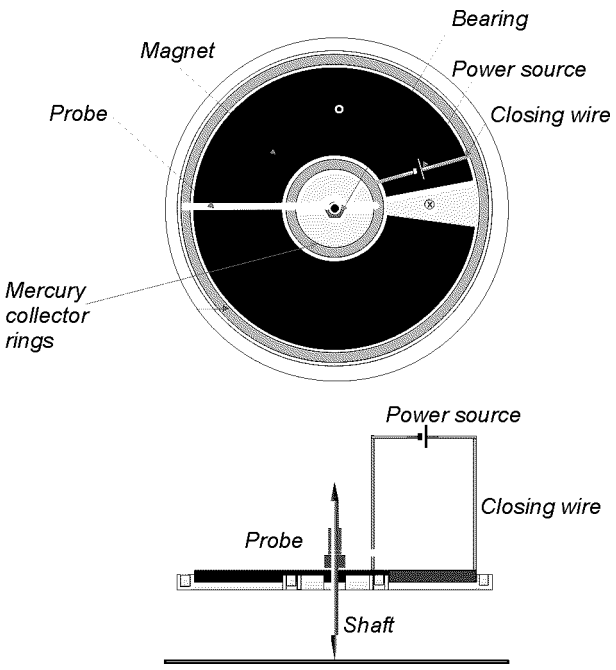

Figure 2: Layout of the Asymmetrical Rotor Applied to the Experiments

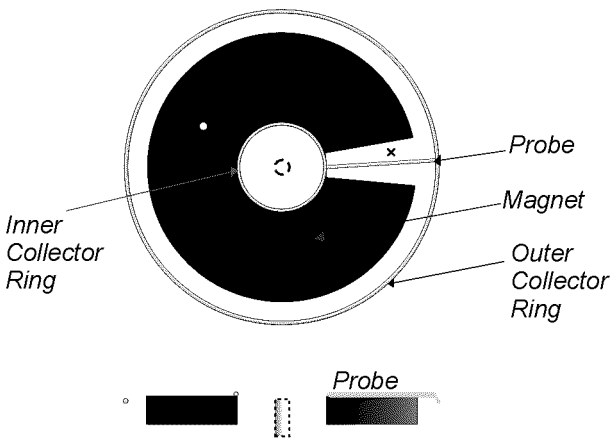

Figure 3: Asymmetrical Rotor Layout as Applied to Experiment 2

generation experiments. Here the magnet was embedded in a teflon disk and was dynamically balanced accounting for the missing mass. The inner and outer copper collector rings enable the instrument's connection closing wire, terminated in carbon-electrode sliding contacts.

3. Experimental

Along the last decade a long series of experiments were performed on unipolar induction, some of them with the aid of the asymmetrical rotor [14,15,16,17,18,19]. Since most of them has been described with much detail [14,15,16,17], we restrict ourselves here to report only two of the whole series. Many of the these experiments were successfully repeated around the world last months [20,21,22,23,24,25,26,27,28,29].

MOTOR CONFIGURATION

a) Rotor anchored to the lab, probe free to rotate above the magnet's downward magnetic field region: As expected by both, relativists and absolutists, a net probe **clockwise** rotation took place when ingoing *dc* was injected. Here the force $F = \int_{probe} I\,(dl \times B)$ is responsible for the observed rotation.

b) Probe anchored to the rotor above the magnet's downward magnetic field region, both free to co-rotate. Contrarily to the absolutistic expectation, a net rotor **counterclockwise** rotation took place when ingoing *dc* was injected. This sole experiment suffices to definitively reject the "dragging" hypothesis.

GENERATOR CONFIGURATION

a) Probe located on the rotor in the magnet's upward magnetic-field region. The rotor in **clockwise** rotation. A voltage $(V_i - V_o)_{uw} > 0$, between the inner and outer ring, was measured. Within the absolutistic framework, the above voltage is generated in the bulk of the probe due to the Lorentz force, which integrated along it gives an $emf = \int_{probe} (v \times B)\,.dr$. As it is obvious, the here involved velocity is the probe's absolute one, since magnet's rotation (provided $\partial B/\partial t = 0$ at each point in the space) is irrelevant within an absolutistic framework [3,4,6,12].

From a relativistic viewpoint, the seat of the voltage is located on the closing wire, which is at relative motion with the magnet. Again, Lorentz force is responsible for the measured $emf' = \int_{closing-wire} (v' \times B)\,.dl$, wherein v' labels the velocity at which the considered closing-wire element moves with respect to the magnet. The fundamental theorem $divB = 0$, plus some elementary symmetry considerations [19] allow us to probe that $emf' = emf$. Briefly speaking, the emf developped on the closing wire at rest in the lab with magnet and probe rotating clockwise, is identical to the emf generated on the clockwise-rotating probe with magnet and closing wire stationary in the lab. The above analysis justifies, *for the first time*, conceptually wrong calculations performed by absolutists when dealing with magnet-probe sets co-rotating in the lab.

b) Probe located on the rotor in the magnet's downward magnetic-field region. The rotor in **clockwise** rotation. Again, and contrarily to absolutists expectations, a voltage $(V_i - V_o)_{dw} > 0$ was measured, as well as in the first case. This sole experiment suffices to definitively reject the absolutistic claims.

4. Dogma versus Experiment

The author of this paper was, in the past, an enthusiastic advocate of the absolutistic paradigm concerning unipolar induction [31,32]. The above due to debatable philosophical reasons and, mainly, to his own ignorance of the powerful machinery underlying Weber's electrodynamics, a true relativistic doctrine also available in the realm of Mechanics [10,11,33]. But dogma are words, and laboratory experiments are real and, sometimes, we are compeled to change old paradigms.

5. Concluding Remarks

The reported experiments show - beyond any reasonable doubt - that a probe wire, when moving attached to the magnet, only plays a passive role (to provide a current path) in the whole phenomenom. Both the ponderomotive and electromotive observed effects are in such a case due to the magnet motion relative to the closing wire.

The key of the succes of the reported experiments lies in the topological features of the magnet's singularity. The short-range field reversion region allows the inversion of the ponderomotive and electromotive effects on the probe, **leaving** the actions on the closing wire **insensitive** to that *B-field* reversion. This very relevant fact was exhaustively checked with the aid of specific experiments [14,15].

Is indeed the Third Newton Law the crucial piece which allows us to rule out the absolutisitic view on homopolar phenomena in a motor configuration. In fact, the whole action can be splitted in two elementary interactions:

Magnet-Probe interaction:

The magnet produces a counterclockwise torque on the probe, and the probe exerts an equal but opposite torque on the magnet.

Magnet-closing wire interaction:

The magnet exerts a clockwise torque on the closing wire, and the wire an equal but opposite torque on the magnet. With the probe attached to the magnet, there is no chance for relative motion between them. Consequently, due to the action-reaction cancellation effect

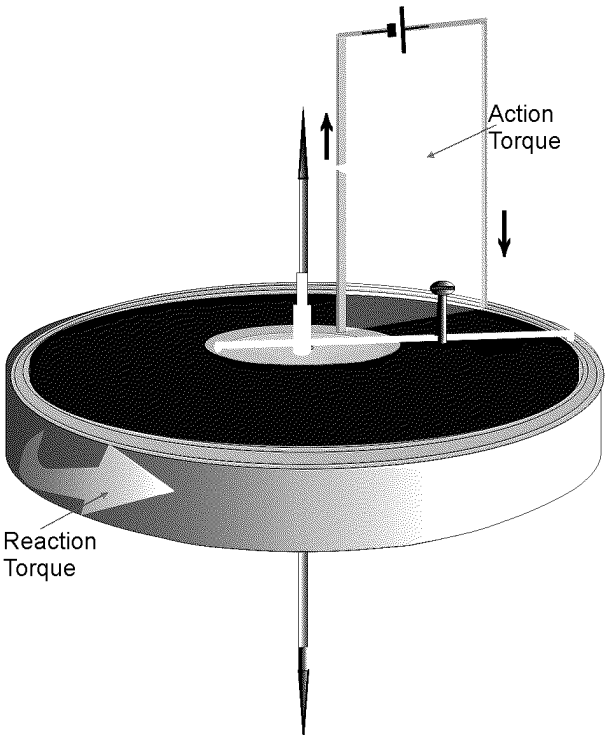

Figure 4: Rotational Torques Acting on the Rotor and on the Closing-Circuit Wire

in this case, rotation is forbidden. Conversely, with the closing wire mechanically decoupled from the magnet, relative motion of the latter is permitted. The torque exerted by the closing wire on the magnet is responsible for the observed rotation (Fig. 4).

After 170 years of controversy and bewilderment, we know that-as far as induction is concerned a wire clockwise rotation upon a stationary magnet is equivalent to a magnet counterclockwise rotation with the wire stationary in the lab (Fig. 5). The above statement, contrary to the customary belief [34], is the main outcome of our pioneering work first advanced in Apeiron [14] and in Spacetime & Substance Journal

The new experimental evidence puts the end point

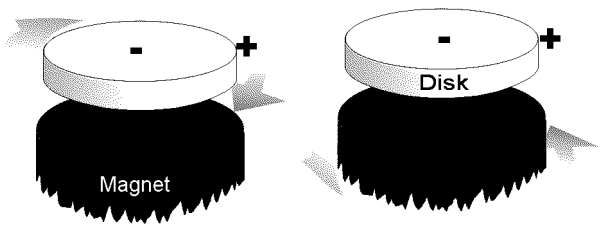

Figure 5: Homopolar induction only depends on the motion of Magnet relative to Disk

to some claims concerning homopolar engines with an efficiency greater than unity [35] and opens the way for further experimental and theoretical search. Particularly, Jehle's electron model deserves to be thoroughly reviewed [3,16].

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