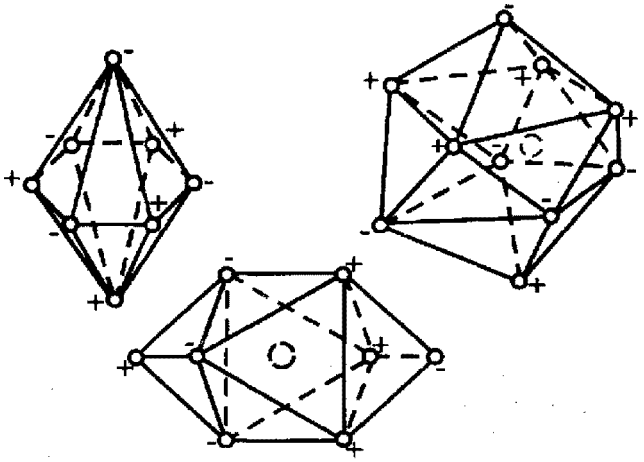
U K R A I N E ISSN 1726-4499

Spacetime & Substance

International Physical Journal



Volume 4, No. 4 (19), 2003

U K R A I N E ISSN 1726-4499

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International Physical Journal

Certificate of the series AB, No. 4858, issued by the State Committee for Information Policy, TV and Broadcasting of Ukraine (February 12, 2001).

The Journal is published by Research and Technological Institute of Transcription, Translation and Replication, JSC(Kharkiv, Ukraine).

It is a discussion journal on problems of theoretical and experimental physics in the field of research of space, time, substance and interactions. The Journal publishes:
— the theories combining space, time, gravitation and others interactions (including the Einstein's SR and GR);
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The volume of one issue is 48 pages. Format is A4. Periodicity: 5 issues per one year during 2000–2002; monthly since 2003. The language is English. The equivalent versions: paper and electronic (*.TEX, *.PS, *.PDF).

Subscription information:

The price of one paper unit is $2.0 in Ukraine, $2.5 in NIS* states, $10.0 in all other countries (plus $1, $1.5 or $10 postage and handling accordingly). The electronic version price is 25% of the paper version price.

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Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 145–151

NEWTON's STATIC POTENTIAL $1/r$ AS THE SPACE RELIEF FORMED BY DYNAMIC INERTONS, CARRIERS OF THE GRAVITATIONAL INTERACTION

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Received June 26, 2003

The real physical space is considered as a mathematical lattice packing by topological balls (or cells, or superparticles). Any deformed cell of such a lattice called the tessellattice is associated with the creation of matter, i.e. a particle. The motion of a particle represents an exchange dynamics, which means that the moving particle exchanges with the tessellattice by bits of deformations carrying by inertons, excitations of the tessellattice. Such a dynamics allows the study in the framework of a specific Lagrangian and the corresponding Euler-Lagrange equations. The result shows that inertons scatter from the particle as a standing spherical wave. Since a spherical wave is specified by the law $1/r$, the following corollary suggests itself: those are the particle's inertons that carry the space deformation (or in other words, the gravitational potential) $1/r$ from the particled cell to the surrounding space inducing Newton's gravitational potential GM/r that hitherto has been interpreted as static.

Key words: space, tessellattice, gravitation, inertons, quantum mechanics

PACS index numbers: 03.65.Bz Foundations, theory of measurement; 04.60.-m Quantum gravity

1. Preliminaries

Finite-size scaling, or scaling laws are studied and applied now at length in many fields of physics. A power-law scale dependence is revealed in measured atomic and molecular systems [1], it is described geometrically in terms of fractals, Mandelbrot [2], and algebraically in terms of the renormalization group, Wilson [3]. Nottale [4] has studied relativity in terms of fractality basing his research on the Mandelbrot's concept of fractal geometry. He introduced a scale-relativity formalism, which allowed him to propose a special quantization of the universe. In his theory, scale-relativity is derived from applications of fractals introduced as follows. The fractal dimension D is defined from the variation with resolution of the main fractal variable, i.e., the length l of fractal curve plays a role of a fractal curvilinear coordinate. He also introduced the topological dimension D_T determining it as $\mathrm{D}_T = 1$ for a curve, 2 for a surface, etc. The scale dimension then was determined as $\delta = \mathrm{D} - \mathrm{D}_T$, namely:

$$\delta = \frac{d \ln l}{d \ln(\ell/\epsilon)}.$$

Then if δ is constant, the above relationship gives a power-law resolution dependence $l = l_0(\ell/\epsilon)^{\delta}$. Such a simple scale-invariant law was identified with a Galilean's kind of scale-relativistic law.

Basically, such approach shows that a trajectory of any physical system diverges due to the inner stochastic nature that is caused by the fractal laws.

In Nottale studies, fractality written in the Mandelbrot's terms is associated simply with the length of a curve. In recent works by Bounias and the author [5-8] we have derived fractal geometry from complete other mathematical principles. In our works we have reconsidered such basic notions as space, measure, and length, which allowed us to introduce deeper first principles for the foundation of fractal geometry. In those works it has uniquely been shown that the space organization on the submicroscopic scale (hypothetically $\sim 10^{-30}$ m) represents a mathematical lattice of empty sets, or a tesselated lattice of primary balls, which has been called the *tessellattice*. A peculiarity of the space at this range, which follows from an analysis of experimental data obtained in high-energy physics, has been associated with the presence of primary blocks, i.e. topological balls (or elementary cells, or superparticles), which are densely packed in the tessellattice forming the degenerate state of the real space.

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The rigorous mathematical theory of space [5-8] has allowed us deeply examine such basic notions as the descent of matter, the foundations of quantum mechanics, the foundations of quantum gravity, and the foundation of quantum electricity. We have shown how space generates matter and physics laws. Matter, i.e. a primary particle, appears in the tessellattice as its local deformation. In other words, a particle is created from a cell (superparticle) whose volume has altered from that of surrounding degenerate cells. Thus the deformed cell is associated with the generation of a massive entity in the degenerate tessellattice.

Our concept is based on topology, set theory and fractal geometry. We in fact could prove that the real physical space is represented by a mathematical lattice:

$$\mathrm{F(U)} \cup \mathrm{(W)} \cup \mathrm{(c)}, \tag{1}$$

where (c) is the set with neither members nor parts, accounts for relativistic space and quantic void, because (i) the concept of distance and the concept of time have been defined on it and (ii) this space holds for a quantum void since it provides a discrete topology, with quantum scales and it contains no "solid" object that would stand for a given provision of physical matter. The sequence of mappings of one into another structure of reference (e.g. elementary cells) represents an oscillation of any cell volume along the arrow of physical time.

However, there is a transformation of a cell involving some iterated internal similarity, which precludes the conservation of homeomorphisms. If N similar figures with similarity ratios $1/\rho$ are obtained, the Bouligand exponent (e) is given by

$$\mathrm{N} \cdot (1/\rho)^{\mathrm{e}} \;=\; 1 \tag{2}$$

and the image cell gets a dimensional change from D to $\mathrm{D}' = \ln(\mathrm{N})/\ln(\rho) = \mathrm{e} > 1$. In this case the putatively homeomorphic part of the image cell is no longer a continued figure and the transformed cell no longer owns the property of a reference cell.

A particled ball provides formalism describing the elementary particles proposed previously by the author in (see, e.g. Refs. [9-12]). In this respect, mass is represented by a fractal reduction of volume of a ball, while just a reduction of volume as in degenerate cells is not sufficient to provide mass. The mass M_A of a particled ball A is a function of the fractal-related decrease of the volume V of the ball

$$M_{\mathrm{A}} \propto (1/V_{\mathrm{part}}) \cdot (\mathrm{e}_\nu - 1)_{\mathrm{e}_\nu > 1}\ , \tag{3}$$

where (e) is the Bouligand exponent, and $(\mathrm{e}-1)$ the gain in dimensionality given by the fractal iteration. Just a volume decrease is not sufficient for providing a ball with mass, since a dimensional increase is a necessary condition.

A local deformation is unstable in the state of rest and represents a field particle, or more exactly, a quasiparticle (excitation) of the real space, which was called the *inerton* [9,10]. It is obvious that the motion of a particle in the tessellattice is accompanied by those tessellattice's excitations, i.e. inertons, which, therefore, are a substructure of the so-called wave-particle. A mechanics of the motion of a particle and its cloud of inertons moving in the tessellattice has been developed in previous papers by the author and it has been shown how such mechanics is reduced to the formalism of conventional quantum mechanics (see, e.g. Refs. [9-12]). It should be emphasized that such an idea, the motion of a particle through an aether substrate when the motion was accompanied by an aether perturbation, held sway over leading mathematicians and physicists of the end 19th and the beginning 20th centuries (see, e.g. Poincaré [13]). Therefore, the idea deserves credit.

Two interaction phenomena have been considered [5-7]. First, the elasticity (γ) of the tessellattice favors an exchange of fragments of the fractal structure between the particled ball and the surrounding degenerate balls. In a first approach, the resulting oscillation has been considered homogeneous. Second, if the particled ball has been given a velocity, its fractal deformations collide with neighbor degenerate balls and exchanges of fractal fragments occur.

The velocity of the transfer of deformations is faster for non-fractal deformations and slower for fractal ones, at slowering rates varying as the residual fractal exponent (e_i). The motion of the system constituted by a particled ball and its inerton cloud provides the basis for the de Broglie and Compton wavelength [9-12].

The system composed with the particle and its inertons cloud is not likely to be of homogeneous shape.

Inertons are carriers of inert properties of the particle and yet they represent a substructure of the particle's matter waves. Since the amplitude of inerton cloud Λ can much exceed the lattice constant (Λ determines the range of the wave ψ-function application), inertons are able to manifest themselves on the macroscopic scale and we have demonstrated this fact experimentally [14] (see also Refs. [15,16]). Moreover, in paper [14] we indeed could experimentally fix the so-called "aether wind" that the Earth experiences at its motion through the space. Therefore, we virtually proved that the quantum mechanical force whose carriers are inertons makes itself evident at the macroscopic range.

Other researchers also observed similar effects. In particular, see results by V. Maiboroda, A. Akimov et al. in Shipov [17], though the changes in samples examined were associated with the so-called "torsion radiation" that was introduced by Shipov as a primary field that allegedly was dominating over a vague physical vacuum long before its creation. An influence a new physical field on specimens was fixed also in Refs.

[18-20] and others.

In the present work the author combines his research on the theory of the real physical space, submicroscopic mechanics constructed in a dozen of works (see, e.g. Refs. [9-12,12-15]) and de Broglie's ideas regarding i) a possible double solution theory that would describe quantum mechanics in the real space and ii) the necessary of the decay of the particle mass at its motion [21]. This will allow us to show how the space deformation, which is carried out by a particle's inertons, is developed around the particle and account for the inner reasons of the distribution of the space deformation in the form of Newtons's gravitational law GM/r.

2. The phenomenon of gravity

In the space beyond the range Λ there is no any information about the particle. This signifies that inertons should also be recognized as actual carriers of the gravitational interaction [10,14] and hence the gravitation should be considered as a pure dynamic phenomenon. So, the gravitational radius of a moving particle is restricted by the amplitude of particle's inerton cloud Λ. The velocity of inertons is rather larger than the speed of light, because the gravitational dynamics is not tested by photons (this was also indicated by Poincaré [13] who for his part referred to Laplace).

Consequently, gravitons of general relativity derived in the framework of the phenomenological approach, which neglected the existence of the matter waves, do not exist in the nature at all. The same result was obtained by Loinger [22]: starting from the Einstein-Gilbert equations, he showed that the solution in the form of so-called "gravitational waves" is not realistic. He pointed out that an alteration in the gravitational potential should be associated with the motion of the front of the metric tensor, but not a vague massless "gravitational wave".

A detailed study of the emission of inertons from a moving particle and their re-absorption points to the fact that the proper mass of the particle periodically decomposes, namely, oscillates between values $m_0/\sqrt{1-v^2/c^2}$ and m_0 within each de Broglie wavelength λ along a particle's path. [23]. Inertons remove volume ΔV (or in conventional physics' terms the mass $m_0 = M_0/\sqrt{1-v^2/c^2} - M_0$), from the particled cell, which has been hidden in its fractal wrinkles, and atomize this deformation in the space around the particle (see also Refs. [6,7]). This induces the deformation field in the space surrounding the particle. The mass of inertons changes from 10^{-70} to 10^{-45} kg [24].

2.1. The contraction of mass

In paper [9] a mechanism that brings to the appearance of the root $\sqrt{1-v^2/c^2}$ at the proper particle mass m_0 has been analyzed. By the mechanism, this is the space response to the particle motion, which contracts the particle and its deformation coat along an entire particle path. The deformation coat (or in other words, the space crystallite) screens the particle from the surrounding degenerate space. It has been argued [10] that the size of the coat coincides with the particle's Compton wavelength $\lambda_{\rm Com} = \frac{h}{Mc}$ that so far has remained rather an enigmatic quantum characteristic of canonical particles. Topology and fractal geometry [6,8] also gives an accurate account of the appearance of the root $\sqrt{1-v^2/c^2}$.

The particle's crystallite travels by a relay mechanism, i.e. states of oncoming superparticles changes from massless to massive when the particle moves to a new position in its path. The contraction of the volume of a moving particle becomes apparent through the increase of the particle mass, $M_0 \to M_0/\sqrt{1-v^2/c^2}$.

Major equations, which allow the analysis of the motion of a system {particle + its crystallite} are equations that describe the motion on an element of a liquid in hydrodynamics:

$$\rho \frac{d\vec{v}}{dt} = -\nabla P; \tag{4}$$

$$\left(\frac{\partial P}{\partial \rho}\right)_{\rm entropy} = c^2. \tag{5}$$

Owing to the discreteness of space on the sub micro scale (hypothetically, $\sim 10^{-30}$ m) and its presentation in the form of the tessellattice, the motion of the crystallite, which is treated as a liquid element now, is also discrete. Then the substantial derivative is transformed to (compere with Ref. [9])

$$\begin{aligned} \frac{df(x)}{dx} &= \lim_{\Delta x \to x_0} \frac{f(x+\Delta x) - f(x)}{\Delta x} \\ &= \lim_{\Delta x \to x_0} \frac{\Delta f}{\Delta x}, \end{aligned} \tag{6}$$

where x_0 stands for the size a of a cell (superparticle) of the tessellattice or for the minimum proper time interval τ that needs the particle to hop from one superparticle to another. Thus equations (4) and (5) change along the particle path as follows

$$\rho \frac{\Delta v}{\tau} = -\frac{\Delta P}{a}; \tag{7}$$

$$\frac{\Delta P}{\Delta \rho} = c^2. \tag{8}$$

With regard for Eq. (8), equation (7) becomes

$$\rho\, \Delta v \frac{a}{\tau} = -c^2 \Delta \rho. \tag{9}$$

Clearly the ratio a/τ is equal to the change in velocity $|\Delta v|$. What is the sign of this value?

It is important to emphasize that we must suggest that canonical particles acquire an inoculating (initial)

velocity non-adiabatically. Then the particle starts to move losing its initial velocity [9,10], which falls from v to 0 within odd sections $\lambda/2$ (the emission of inertons) and increases from 0 to v within even sections $\lambda/2$ (the re-absorption of inertons) of the particle path. Therefore, since $\Delta v = v_{\text{current value}} - v_{\text{initial}}$, we obtain that the sign is minus within the odd sections and is plus within the even sections.

Thus eq. (9) can be represented as follows:

$$\rho\,(v - v_0)(v_0 - v) = -(\rho - \rho_0)\,c^2$$
odd sections; (10)

$$\rho\,(v_0 - v)(v_0 - v) = -(\rho_0 - \rho)\,c^2$$
even sections. (11)

These equations result in equation for the density

$$\rho = \frac{\rho_0}{1 - \frac{(v_0 - v)^2}{c^2}}. \tag{12}$$

Since the solution for the velocity v is equal to [9,10]

$$v = v_0\big(1 - \big|\sin\frac{\pi t}{T}\big|\big), \tag{13}$$

equation (12) is reduced to the following

$$\rho = \frac{\rho_0}{1 - \frac{v_0^2}{c^2}|\sin\frac{\pi t}{T}|^2}. \tag{14}$$

Since the mass is proportional to the inverse volume of the particle (3), we can write relationship

$$\rho \propto \frac{1}{V_{\text{part}}^2} \tag{15}$$

and, therefore, taking into account Eqs. (3), (12), and (13) we obtain

$$M = \frac{M_0}{\sqrt{1 - \frac{v_0^2}{c^2}\big|\sin\frac{\pi t}{T}\big|^2}}. \tag{16}$$

Thus we have derived the law of behavior of the particle mass. The expression (16) is very important for the study of the particle dynamics at microscopic scales close to the de Broglie wavelength, because of the relation $\lambda = vT$. In the limit $t >> T$, where T is the period of the particle oscillations along its path, which is connected with the particle frequency $\nu = 1/2T$ [9,10], Eq. (16) is reduced to well-known expression

$$M = \frac{M_0}{\sqrt{1 - \frac{v_0^2}{c^2}}}. \tag{17}$$

2.2. The equations of motion

Having considered the generalized exchange dynamics of a particle's inertons whose emission and reabsorption result in the oscillation of the particle mass (16), we have to construct an appropriate Lagrangian. The Lagrangian should consist of : 1) terms that describe the kinetics of the particle and its inertons, which then should result in the formalism of conventional quantum mechanics, and 2) terms that reflect the behavior of mass of the system {particle + particle's inertons}.

Obviously the Lagrangian combined the kinetics and the mass dynamics of the system studied should be constructed on the basis of those proposed in Refs. [9,10] and [23]. Let us write the Lagrangian as follows

$$L = -M_0c^2\Big\{1 - \frac{1}{M_0c^2}\Big[M_0\dot{X}^2 + m_0\dot{x}^2 - \frac{2\pi}{T}\sqrt{M_0m_0}\,(X\dot{x} + v_0x)\Big] - T^2\Big[\dot{\mu}^2 + \dot{\vec{\Xi}}^2 - \hat{c}\,\dot{\mu}\nabla\vec{\Xi}\Big]\Big\} \tag{18}$$

and its value should be equal to

$$L = -M_0c^2\sqrt{1 - \frac{v_0^2}{c^2}}. \tag{19}$$

2.2.1. Kinetics of the system {particle + particle's inertons cloud}

It has been argued [23] that the kinetics of the particle and its inertons, which can be derived basing on the Lagrangian (15), is launched by collisions of the moving particle with the oscillating mode of the crystallite. The vibratory energy stored in the crystallite does not run low, because it is kept by the entire tessellattice.

In expression (18), M_0, X, and $\dot{X}$ are the mass, the particle position, and the velocity of the particle; T is the period of collisions between the particle and its inertons cloud; m_0, x, and $\dot{x}$ are the mass, the position, and the velocity of the center of mass of the inertons cloud.

The other part of the Lagrangian (18) includes the dimensionless variable $\mu = m/m_0$ that denotes the relative mass of the inerton cloud, where m is the current value of the inerton cloud's mass and m_0 its initial value that characterizes the cloud at the moment of its emission from the particle. This second part of the Lagrangian describes the return motion of the inertons cloud that travels through the tessellattice strongly interacting with it as follows: along a path, the mass (the local deformation) is gradually transformed into the other kind of the tessellattice deformation, called the *rugosity*, which does not destroy the morphism of a cell, but translates the cell from its equilibrium position in the tessellattice. Such kind of the entire deformation of the tessellattice gives rise to its local tension. This elastic tension is removed by the energy stored in the tessellattice, or in other words, the tessellattice restores

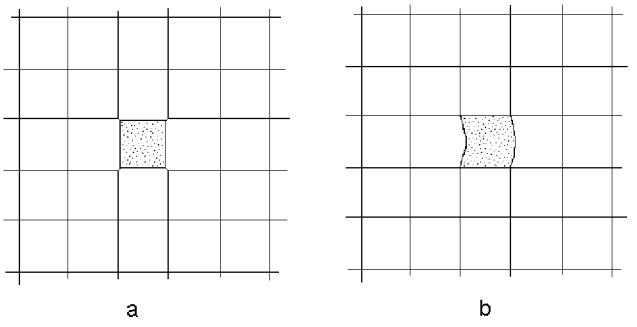

Figure 1: Two limiting cases for the state of an inerton from the particle's environment in the space net: (a) the deformation, i.e., the volume change is localized in the cell (here, the inerton mass $m_i \neq 0$); (b) there is no deformation in the cell (here, $m_i = 0$, or in other words, the volume of the cell does not distinguish from that of nearest cells) while the local deformation is completely transferred into the rugosity of the tessellattice (it is supposed that the inerton moves from the left, the particle location, to the right and backwards under the pressure on the side of the tessellattice).

its initial state in which every cell occupies its own equilibrium position.

Once again, what is the rugosity $\vec{\xi}$ in terms of the tessellattice? Fig. 1 demonstrates the difference in two notions that our concepts operate with: the massive state of a cell of the tessellattice (Fig.1a) and the state of a cell in which the cell being topologically undistorted [6,8] shifts from its equilibrium position (in the case when a number of cells shifts, because the particle emits a could of inertons, we can talk about the "rugosity of the tessellattice", Fig. 1b).

In the Lagrangian (18), $\vec{\Xi} = \vec{\xi}/|\vec{\xi_0}|$ is the dimensionless vector that describes the rugosity of the tessellattice in the range covered by the inertons cloud, where $\vec{\xi}$ is the current value of the rugosity at the moment t and $\vec{\xi_0}$ its maximum value at a distance of Λ from the particle (recall that Λ is the amplitude of the inertons cloud, which shows how far from the particle the cloud spreads). We also assume that the start velocity of inertons $\hat{c}$ emitting from the particle may exceed the speed of light c, though the limiting velocity shows up in expression (17).

2.2.2. Figures

Now we can proceed to the Euler-Lagrange equations. For conventional variables X, $\dot{X}$ and x, $\dot{x}$ they are

$$\frac{d}{dt}\frac{dL}{d\dot{Q}} - \frac{\partial L}{\partial Q} = 0, \tag{20}$$

where $Q \equiv \{X,\ \dot{X};\ x,\ \dot{x}\}$, which bring about the solutions [9,10]

$$\dot{X} = v_0\Big(1 - \Big|\sin\frac{\pi t}{T}\Big|\Big); \tag{21}$$

$$X = v_0 t + v_0\frac{T}{\pi}\Big\{(-1)^{[t/T]}\cos\frac{\pi t}{T} - \Big(1 + 2[\frac{t}{T}]\Big)\Big\}; \tag{22}$$

$$\dot{x} = (-1)^{[t/T]}\,\hat{c}\,\cos\frac{\pi t}{T}; \tag{23}$$

$$x = \frac{\Lambda}{\pi}\Big|\sin\frac{\pi t}{T}\Big|, \tag{24}$$

where the notion $[t/T]$ means an integral part of the integer t/T. The connection with parameters of conventional quantum mechanics is reached through the relationships

$$\lambda = v_0 T, \quad \Lambda = \hat{c}T, \quad \nu = \frac{1}{2T}. \tag{25}$$

If we pass on to the de Broglie relationships for a particle

$$E = h\nu, \quad \lambda = \frac{h}{M v_0}, \tag{26}$$

we will derive the formalism of conventional quantum mechanics (the Schrödinger equation, etc.) [9,10].

2.2.3. Mass dynamics of the inertons cloud

Regarding the variables μ and $\vec{\Xi}$ in the Lagrangian (18), we have to use the Euler-Lagrange equations in the form (because of the function $\nabla\vec{\Xi}$, see e.g. ter Haar [25])

$$\frac{\partial}{\partial t}\frac{\partial L}{\partial \dot{q}} - \frac{\delta L}{\delta q} = 0, \tag{27}$$

where the functional derivative

$$\frac{\delta L}{\delta q} = \frac{\partial L}{\partial q} - \frac{\partial}{\partial x}\frac{\partial L}{\partial(\frac{\partial q}{\partial x})} - \frac{\partial}{\partial y}\frac{\partial L}{\partial(\frac{\partial q}{\partial y})} - \frac{\partial}{\partial z}\frac{\partial L}{\partial(\frac{\partial q}{\partial z})}. \tag{28}$$

The equations for μ and $\vec{\Xi}$ obtained from Eqs. (27) and (28) are

$$\frac{\partial^2\mu}{\partial t^2} - \hat{c}\nabla\dot{\vec{\Xi}} = 0; \tag{29}$$

$$\frac{\partial^2\vec{\Xi}}{\partial t^2} - \hat{c}\nabla\dot{\mu} = 0. \tag{30}$$

These equations can be uncoupled [23], which yields (Δ is the laplace operator)

$$\frac{\partial^2 m}{\partial t^2} - \hat{c}^2\Delta m = 0; \tag{31}$$

$$\frac{\partial^2\vec{\xi}}{\partial t^2} - \hat{c}^2\,\nabla\cdot\nabla\vec{\xi} = 0 \tag{32}$$

(here we come back to dimensional variables: the mass m of the inertons cloud and the rugosity $\vec{\xi}$ induced

in the range of the tessellattice covered by the inerton cloud).

Since the system studied features the radial symmetry, equation (31) should be rewritten in the spherical coordinates

$$m_{tt} - \hat{c}^2 \frac{1}{r}(rm)_{rr} = 0 \tag{33}$$

(recall that in the spherical coordinates the Laplace operator is $\Delta = \frac{1}{r}\frac{\partial^2}{\partial r^2}(rm)$). Thus the wave equation (33) possesses the radial symmetry.

Let us set the following initial conditions to the variable $m(r,\ t)$:

$$m(r,\ 0) = m(r); \tag{34}$$

$$\frac{\partial m(r,\ 0)}{\partial t} = 0; \tag{35}$$

the boundary condition

$$\frac{m(r,\ t)}{\partial r}\Big|_{r=\Lambda} = f(r,\ t). \tag{36}$$

The conditions (34)-(36) mean that the mass $m(r,\ t)$ initially has located in the center of coordinates of the system studied, i.e. in the particle, $m(r,\ t)|_0 = m(0,\ 0) = m_0$. Obviously the total mass of the inertons cloud is

$$m_0 = \frac{M_0}{\sqrt{1 - \frac{v_0^2}{c^2}}} - M_0. \tag{37}$$

Due to the radial symmetry and in view of conditions (34)-(36), the solution to equation (33) is typical for a standing spherical wave, which features the dependance $1/r$:

$$m(r,\ t) = C\frac{m_0}{r}\cos\frac{\pi r}{2\Lambda}\left|\cos\frac{\pi t}{2T}\right|, \tag{38}$$

where C is the constant and r varies from the particle size $r \sim 10^{-30}$ m to the amplitude of the inertons cloud $r = \Lambda \approx \lambda\hat{c}/v_0$.

The distribution of the inert mass of the particle is described by the amplitude of the mass of the inertons cloud

$$\frac{m_0}{r}\cos\frac{\pi r}{2\Lambda} \tag{39}$$

that oscillates in the space around the particle with the period T. Since an elementary mass is determined as a local deformation of the tessellattice (2) (see also Fig. 1a), the distribution of the inert mass of in the space around the particle is given by expression (39).

In the region of space between the particle's crystallite whose size is defined by the Compton wavelength $\lambda_{\rm Com} = \frac{h}{Mc}$ and the amplitude Λ of the inertons cloud, i.e. $\lambda_{\rm Com} < r < \Lambda$, the time-averaged distribution of the mass of the inertons cloud in the limit $v_0 << c$ becomes

$$m(r) = C\frac{v_0^2}{c^2}\frac{M_0}{r}. \tag{40}$$

If we multiply expression (40) by factor $-G/(C \cdot \frac{v_0^2}{c^2})$, where G is the gravitational constant, we obtain Newton's gravitational potential of the particle

$$U(r) = -G\frac{M_0}{r}. \tag{41}$$

In paper [23] we have shown how this result spreads to the gravitational potential of a macroscopic object. As follows from expression (39), the gravitational potential U in Newton's law (40) should also be a function of the absolute velocity v_0 at which the object moves in the tessellattice. It is an interesting result, because it can shed some light on experimentally confirmable deviations from Newton's law, such as the motion of the Mercury perihelion, the deviation of light by the sun, and the red shift, which have been predicted by the phenomenological theory of relativity, namely, the Einstein-Gilbert equations.

In the Lagrangian (18), the two kinds of terms describing the kinetics and the dynamics of the system {particle + its inertons} have been written in a first approximation in which the terms do not interference. However, even this prime approximation has been found successful. It has enabled us to prove that dynamic inertons in fact form a space relief that allows the interpretation in terms of the static gravitational potential of a particle.

3. Conclusion

In this paper based on the rigorous mathematical theory of the real physical space constructed by M. Bounias and the author [5-8] and the mechanics of canonical particles [9-12,14-15,23,24] in the real space considered as the tessellattice, we have shown that excitations of the tessellattice, inertons, caused by the motion of a particle in fact are carriers of both the quantum mechanical and gravitational interactions. Besides, we have shown that the phenomenon of gravity is caused by the defractalization of the contracted moving object. The deformation described in terms of inertonic mass (37) is periodically stripped from the object and atomized around it. Thus it is the contraction of the space around the object that generates the attractive potential in the form of Newton's gravitational law (41).

It is interesting to emphasized that a hundred of years ago Poincaré [13] indicated the main reasons for gravity. By Poincaré, the expression for the attraction should include two components: one is parallel to the vector that joins positions of both interacting objects and the second one is parallel to the velocity of the

attracted object. Thus the velocity of an object must influence the value of its gravitational potential. Grand Poincaré was at the origin of topology, he understood how the generalized theory of space was important for physics. Now his ideas are sustained by the results presented in this work.

In the next work we shall demonstrate how dynamic inertons introduce a correction to Newton's gravitational law accounting for the effects predicted by the formal phenomenological theory of general relativity.

References

[1] S. Kais, and P. Serra, in *Advances in Chemical Physics*, Eds: I. Prigogine and S. A. Rice, John Wiley & Sons, Inc., **125**, pp. 1–99 (2003).

[2] B. Mandelbrot, *Les Objets Fractals* (Flammarion, 1975); *The fractal geometry of nature*, (Freeman, 1983).

[3] K. Wilson, *Rev. Mod. Phys.*, **47**, 774 (1975).

[4] L. Nottale, "Scale-relativity and quantization of the universe I. Theoretical framework," *Astron. Astrophys.*, **327**, 867–889 (1997);.

[5] M. Bounias, V. Krasnoholovets, *Kybernetes: Int. J. Syst. & Cybernet.*, (2003), **32**, no.7/8, 945–975 (also physics/0211096).

[6] M. Bounias, V. Krasnoholovets, *Kybernetes: Int. J. Syst. & Cybernet.*, (2003), **32**, no.7/8, 976–1004 (also physics/0212004).

[7] M. Bounias, V. Krasnoholovets, *Kybernetes: Int. J. Syst. & Cybernet.*, (2003), **32**, no.7/8, 1005–1020 (also physics/0301049).

[8] M. Bounias, V. Krasnoholovets, *Int. J. Comput. Anticip. Systems*, **13** (2004), to be published.

[9] V. Krasnoholovets, *Phys. Essays*, **10**, 407–416 (1997) (also quant-ph/9903077).

[10] V. Krasnoholovets, *Ind. J. Theor. Phys.*, **48**, 97–132 (2000) (also quant-ph/0103110).

[11] V. Krasnoholovets, *Spacetime & Substance*, **1**, 172–175 (2000) (also quant-ph/0106106).

[12] V. Krasnoholovets, *Int. J. Comput. Anticip. Systems*, **11**, 164–179 (2002) (also quant-ph/0109012).

[13] H. Poincaré, "Sur la dynamique de l'électron," *Rendiconti del Circolo matematico di Palermo*, **21**, 129–176 (1906); also: Oeuvres, t. IX, pp. 494–550 (also in Russian translation: H. Poincaré, *Selected Transactions*, ed. N. N. Bogolubov (Nauka, Moscow, 1974), vol. 3, pp. 429–486).

[14] V. Krasnoholovets, V. Byckov, *Ind. J. Theor. Phys.*, **48**, 1–23 (2000) (also quant-ph/007027).

[15] V. Krasnoholovets, *Ind. J. Theor. Phys.*, 49 (2001) 1–32 (also quant-ph/9906091).

[16] V. Krasnoholovets, cond-mat/0108417.

[17] G. I. Shipov, "The theory of physical vacuum." Nauka, Moscow, 1997, pp. 247–296 (in Russian).

[18] M. S. Benford, *J. Theoretics*, **4** 1 (2002) http://www.journaloftheoretics.com/Articles/4-1/Benford-axion.htm

[19] L. I. Urutskoev, V. I. Liksonov, V. G. Tsioev, *Ann. Fond. L. de Broglie*, **27**, 701-726 (2002).

[20] Yu. A. Baurov, *Ann. Fond. L. de Broglie*, **27**, 443-461 (2002).

[21] L. de Broglie, *Compt. Rend.*, **264 B**, (16), 1173–1175 (1967).

[22] A. Loinger, "On black holes and gravitational waves." LA Goliardica Pavese, Pavia, 2002.

[23] V. Krasnoholovets, hep-th/0205196.

[24] V. Krasnoholovets, *Spacetime & Substance*, **2**, 169–170 (2001) (also quant-ph/0201131).

[25] D. ter Haar, "Elements of Hamiltonian mechanics," Nauka, Moscow, 1974, p. 211 (Russian translation).

Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 152–163

SOME FUNDAMENTALS OF A SUBSTANCE STRUCTURE

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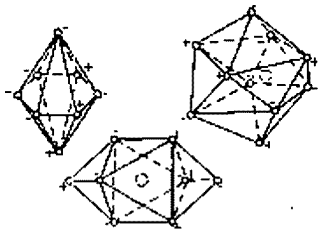
Received Jule 26, 2003

The authors' publications and their experimental data for the period since 1955 finally proved that the controlled nuclear (correctly atom) transformation is not only possible, but also it is not too hard being performed technically. The authors of the work have formulated their concepts as for nuclear ideology, which, finally, have not allowed only to create the harmonious theory of the atom structure, but prove experimentally the opportunities of atom splitting into fragments and its synthesis, i.e. enlargement as well. Brief operational description of the experimental thermal reactor, the electrolyze effects by a pulse current without a constant component and the summary data of the experiments results are shown.



"The brain is a lantern,
which a human being carries
in front of himself, and the genius
is the Sun illuminating the whole Universe."

Schopenhauer

1. Introduction

We omit the official science criticism concerning the substance transformation, as it is based on the elementary ignorance of major substance fundamentals by some physicists. Currently more than a thousand articles and books are published, which admit or deny the processes in substances resulting in atoms reorganization. The majority of these publications deny the cold synthesis opportunities, i.e. controlled nuclear transformations. Now the authors' publications and their experimental data for the period since 1955 finally proved that the controlled nuclear (correctly atom) transformation is not only possible, but also it is not too hard being performed technically.

The surnames of the persons, who told the gold words of the TRUTH, that gave energy to mankind, and the life prolongation of the mankind on the Earth and in Space along with it, should be mentioned in a short article. Perhaps, the French astronomer Pru was the first, who told, that all the atoms, in this or other way, consist of hydrogen and all of them should be splitted into the same atoms as well.

The Frenchman was also the second astronomer. His name was K.L. Kervan. Though K.L. Kervan had no experimental proof of the substance transformation, but he had the complete belief, that such transformations occur in nature permanently.

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The experimental proofs are necessary, which occurred nevertheless, but they were referred to artifacts. Dave Hudson's experiments were interesting especially. The authors tell about them in their book "The truth and the substance structure fundamentals," which is at the registration in the State Registrar. Then it is possible to mention M. Fleshman and S. Pounce [32], but their idea does not differ from L. Kervran's statements, and, therefore, has no scientific interest.

The later experimental researches are referred to 2000–2003. The name of the corresponding member of the Russian Academy of Sciences V.F. Balakirev as well as the names of V.V. Krimsky, A.V. Vachaev, L.I. Urutskoev [25,26,27] should be called here. These persons could be the co-authors of the century epoch-making discovery of the controlled nuclear transformation, from our point of view.

The discovery has been made, but not considered by official authorities yet. Some fundamental directions are planned in the schedule of works as for the substances nuclear transformation. The appropriate applications for the discovery were made by the authors as well (see the Reference).

The listed applications for the discovery, on one hand, specify the priority of Ukraine and Russia as to nuclear substances transformation, and, on the other hand, practical achievements in this area. Our achievements are not successive in nuclear physics and though can not serve as continuation of the early science as

for the substance nuclear structure. The authors of the work have formulated their concepts as for nuclear ideology, which, finally, have not allowed only to create the harmonious theory of the atom structure, but prove experimentally the opportunities of atom splitting into fragments and its synthesis, i.e. enlargement as well. The author's elements system similar to the Mendeleyev's elements system has been created. But it is called as the izostere table, in which Mendeleyev's 105 elements have made only the small part of our table. There are more than ten thousand elements, making their whole world, and opening incredibly wide opportunities in the scientific area of the substance knowledge, in the Bolotov's izostere table [24].

Let's list ours points of view briefly as for the substance structures with strokes, as we do not use anybody's theories.

We shall begin the ether and substances definition from postulates as well, which we are not going to prove to anybody and we shall consider them as truths presumably.

The authors assume that the whole extended three-dimensional endless space, foreseeable by a man is absolutely empty. Therefore the extended space has no other properties, except wave ones. We shall call it as "ether" according to the old scheme. The ether, as the medium with zero properties, nevertheless is capable to transfer the oscillatory perturbations, if these oscillatory perturbations are three-dimensional. Really, the movement of ordinary one-dimensional waves is impossible at an elementary level in the ether medium with zero parameters. Therefore the oscillatory processes at the level of standing waves are possible in the ether. It is easy to imagine that the three-dimensional standing wave will look like two spherical antinodes. One of the antinodes corresponds to the positive semi-wave sinusoids, and the second one corresponds to the negative semi-wave sinusoids. The authors called the standing wave, i.e. the first spherical antinode, as "electron," and the second spherical antinode as "positron." Thus, electron and positron (or π-electron), though are mutually opposite, they can not annihilate with each other, as, a matter of fact, are semi-waves of the same sinusoid, but three-dimensional one.

Spherical antinode in the ether behaves as a substance. Really, as the standing wave is adhered to any space point, so its position in space is possible only in the distance equal to a half-cycle. In other words, the standing waves position is discrete strictly. Therefore, some effort can be applied to move the antinode in space, as the antinode can skip over the area in space only not less than the half-period. Hence electrons and π-electrons, being the wave standing surges, on one hand, and, the elementary substance having the property resisting to movement, i.e. the mass property, on the other hand.

In other words, the substances are got on the basis of electrons and π-electrons, which are formed as crystal formations on the basis of Platon's bodies and not Platon's ones especially. Thus the substances are the products of the ether medium generated as standing waves (antinodes). The ether and substance are the same. Therefore the substance disintegration is reduced to the substance transformation into the ether medium. The substance, thus, as well as the ether does not consist of anything, but it is possible to admit, that the ether consists of the space filled with ideal Lomonosov's ultra-space particles, and a pair of electrons and π-electrons, we shall call it as the electron-positron resonator (EPR).

The atom structure has been already given in details in the papers [29–31].

2. The Electrolyze Effects by a Pulse Current without a Constant Component

The opportunity research of the directed nuclear electrolyze by current pulses, which does not contain constant component both in a voltage spectrum and current spectrum, is rather interesting for inorganic nuclear synthesis and division. There are cathode and anode processes with the participation of weakly electroconducting electrolytes. Besides the processes, accompanying with the electrode material dissolution with the formation of ions, protons, neutrons frequently occur at the electrolyze, which, finally, result in the formation of so-called electroinorganic compositions, free radicals of high energy and ion-radicals [16]. The pulse form of the used voltage is important for the realization of the directed electrolyze. The elementary form of an electrical voltage is the sinusoid (Fig. 1, a).

It is not suitable, for example, for electrical precipitation, as the alternating processes of electrode precipitation and dissolution compensate each other at current direction change.

However the partial precipitation and the precipitation at a symmetric voltage, which do not contain the constant component at the expense of the various metal valve effect, are possible. The imposing of the constant component onto the alternating current (the Fig. 1, c), improves the process of metal electrolyze. However, the imposing, applied according to V. Marchez's scheme for the first time, appears effective only at electrical precipitation. Other versions of the imposing schemes of a constant component onto the alternating current were applied as well; thus the form of the output voltage looks like (Fig. 1, c). The voltage form is given in the Fig. 1 at the double period rectification. Mr. A.K. Krivtsov used the thyristor device, with which he managed to increase the pulse current density up to 25 A/dm^2. The voltage pulses form on the bath electrodes is close to rectangular and they are located from

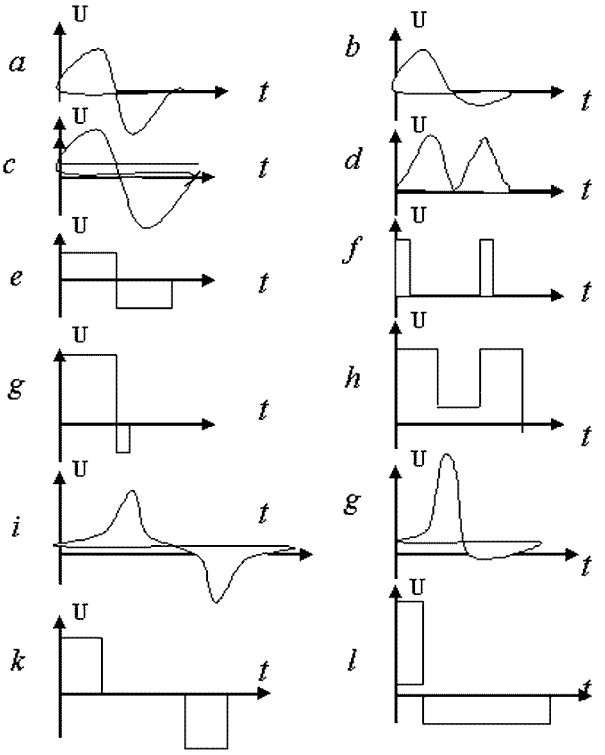

Figure 1: The voltage pulses for the electrolyze purposes

each other at significant distance (Fig. 1, f). Now there are many various pulse voltage sources, ensuring pulses creation almost of any form. Some of them are given in the Fig. 1. However, the obligatory combination of a constant component to the alternating current components was used in all described cases. The research purpose was the study of electrolyze properties and effects at the special form of a pulse, asymmetric voltage regarding the time axis, but not containing a constant component in its spectrum. Thus it is expedient to investigate two cases: when the constant component is absent in the voltage pulses spectrum and in the current pulses spectrum. Specific feature of such voltage is the constant equality of the integrated areas of positive and negative pulse semi-waves (Fig. 1, g, i). These pulses spectrum contains even components mainly. Such pulse forms can be received by the saturation throttles practically for any capacities. Though any electrolyze bath has nonlinear, but symmetric, volt-ampere dependence, so the straightening bath property can be observed at an asymmetric voltage. The naturally arisen constant component in the bath electrode circuit will derive the processes earlier unknown. On the other hand, the pulse voltage of the asymmetric form without a constant component allows getting the current asymmetric form in a bath as well. The definition of the passing phenomenon of the electrolyze directed process in electrolytic bath from electrical current, not containing the constant component, makes estimate the new Faradey's law afresh. Really, the quantity of the transferred substance in a bath is proportional to the electricity quantity which has leaked through electrodes according to the Faraday's law. In our case the electricity amount of a pulse current without a constant component always is equal to zero. However the directed processes occur in a bath. In other words, the authors have found out other phenomena at the asymmetric current pulses affect without constant component, having no relation to the Faraday's law, but determining to nuclear transformations.

Let's consider briefly, what the electrical straightening principle of the voltage pulse of the asymmetric form for the case means, when the applied voltage has the rectangular form (Fig. 1, i). The amplitudes of positive and negative current semi-waves will differ from voltage amplitude proportions by virtue of the bath nonlinear electrolyte properties. It is well clear from the diagram 2a.

If the electrolytic bath has non-linearity (J, U), as it is shown in the Fig. 2 (curves 1 and 2), so the current pulses values will be presented by the diagrams 3 and 4. It is possible to compare, that the current pulses value will be other at linear dependence, namely the current pulses maximal amplitude will be limited by the level 4". Comparing the pulse and current diagram 3 and 4 with the current diagram, which would be received at linear dependence (J, U) of the bath (2"), it can be established, that the area of a positive current pulse will be much bigger than the area of the negative semi-wave, i.e.

$$J_1 \cdot \tau_1 > j_2 \cdot \tau_2. \tag{1}$$

At the same time the initial voltage areas are always given as equal i.e.

$$U_1 \cdot \tau_1 = U_2 \cdot \tau_2. \tag{2}$$

The peak capacity of a positive pulse in loading will be:

$$P_1 = \frac{U_1^2}{R} = J_1 U_1. \tag{3}$$

Accordingly the peak capacity of the negative semi-wave will be:

$$P_2 = \frac{U_2^2}{R} = J_2 U_2 \tag{4}$$

If to take into account, that

$$U_2 = U_1 \frac{\tau_1}{\tau_2}, \tag{5}$$

so accordingly:

$$P_2 = \left(\frac{U_1 \tau_1}{\tau_2}\right)^2 \cdot \frac{1}{R} = P_1 \left(\frac{\tau_1}{\tau_2}\right)^2. \tag{6}$$

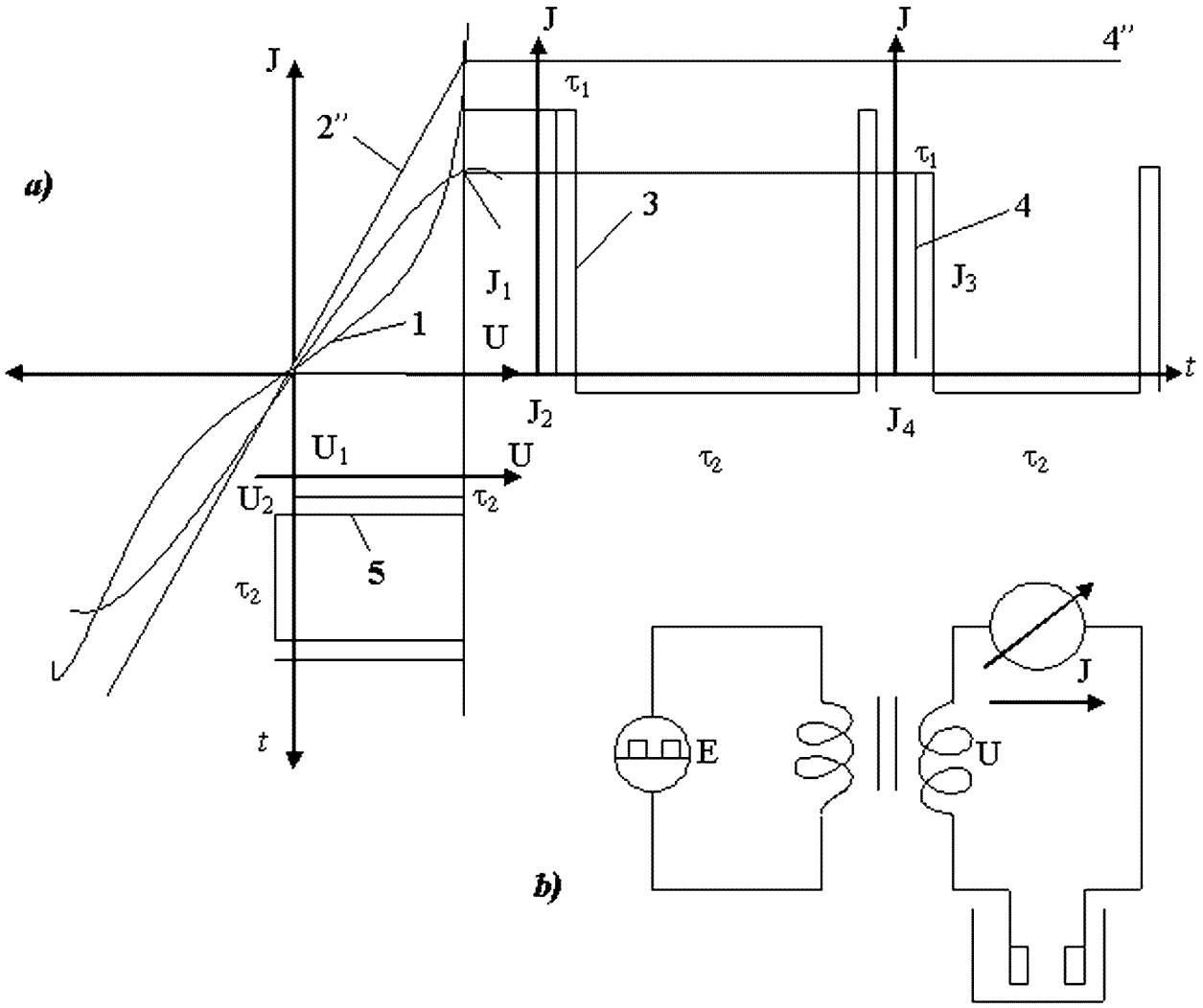

Figure 2: The effect explanation of asymmetric rectification

We can see from this expression that the pulse capacity in loading, developed in the positive wave bath, is larger than the negative wave by the following amount

$$\left(\frac{\tau_1}{\tau_2}\right)^2. \tag{7}$$

The average value of capacities is various as well. They will be accordingly:

$$P_{1cp} = \frac{U_1^2 \tau_1}{R\left(\tau_1 + \tau_2\right)}; \tag{8}$$

$$P_{2cp} = \frac{U_1^2 \tau_1^2 \tau_2}{R\left(\tau_1 + \tau_2\right)\tau_2^2} = P_{1cp}\frac{\tau_1}{\tau_2}. \tag{9}$$

It follows from here, that the semi-wave energies of loading current pulses will differ as well. Thus, the energies of the pulse voltage of the asymmetric form even in linear loading are distributed non-uniformly regarding the time axis. At the same time the semi-wave energies of simply sinusoid voltage are absolutely equal. The asymmetric voltage (Fig. 1, i) consists only of the harmonic component sum. However this sum nature is those, that thus there is the energy formation preferably to one party. This remarkable wave energy property means, that the sum of even and odd harmonic components makes the energy direction overturning regarding the time axis. This phenomenon is fair as well not only for temporary processes, but also for spatial. **Here the separate action sum from odd and even harmonic fluctuations is not equal to total action from the sum of odd and even harmonic fluctuations**. Such property of the pulses source of the asymmetric form without a constant component to redistribute energy asymmetrically regarding the time and space axis, is one of the major affecting factors

Table 1: The summary data of the experiments results

The experiment purpose and voltage pulses form	Distance between electrodes, mm	Area of electrodes, cm^2	Duration of electrolyze, min.	Average value of the current pulses, A	Constant component, mA	Change of electrode mass at electrolyze, g	Remarks and conclusions
Research of the substance precipitation opportunity (Diagr. 1, i)	1	1	60	0.23	0	Δ_a=−0.0020 Δ_k=−0.0005	Asymmetrical electrodes dissolution
Effect amplification at the expense of frequency increase up to 200 pls/sec.	50	1	60	0.06	0	Δ_a=−0.0033 Δ_k=−0.0005	Gases and residue release in the zone of the anode electrode
The experiment repetition at the frequency 100 pls/sec	50	1	120	0.03	0	Δ_a=−0.0089 Δ_k=+0.0002	Dissolution of an anode electrode increased almost in 40 times
The opportunity definition of platinum dissolution in 30% solution HNO_3 The frequency 200 pls/sec	50	Platinum wire	60	0.06	0	Δ_a=−0.0012 Δ_k=−0.0002	Dark-gray residue precipitated under anode electrode
The same experiment, but with solution NCl. The pulse frequency 50 pls/sec	50	The same	240	0.015	0	Δ_a=−0.0018 Δ_k=−0.0000	The same residue

upon substances, their nuclear transformation and not only in the electrolytic bath, but in the ether medium as well. The asymmetric form voltage without a constant component can be got from the pulse generator of any form with a transformer output, or passed the pulses through the condenser. So it is clear, as the transformers do not work by a constant current, so they are not capable to transform the voltage constant component, and the condensers do not pass the current constant component. The nuclear transformations are best for the observing in solutions or melts. Really, for example, let's subject the ordinary distilled water (H_2O) to pulse excitation. Water usually dissociates into hydrogen and oxygen ions. Now, if to pay attention to a hydrogen ion, it is possible to find out, that it represents an ordinary proton, i.e. a nuclear particle from the point of view of modern nuclear physics. From our point of view, as we deny the Borovsky's planetary system, a hydrogen ion is an ordinary proton, or charged neutron, i.e. a nuclear particle. Hence the electrolyze process, i.e. the ions carrying is the ordinary nuclear transformation. But in order to observe this process just as it is, its constant component should be removed from voltage pulses. Then Faraday's ion movement will not be, as there is no constant component. Other movement will be instead of it. It completely concerns to nuclear movements resulting in nuclear transformations, as the protons, neutrons and mesons react not so much to the electricity amount of the electrical field, but its power parameters.

The results of the executed electrolyze show, that there is a unidirectional dissolution of an anode electrode at asymmetric voltage and at the absence of the current constant component. The anode electrode means the electrode, on which positive potential is designated at the initial moment of the large pulse receipt. There is a process similar to electroerosion. Actually the nuclear transformations are made here, as the anode electrode, being excited, begins emitting not only electrons, but also protons, neutrons, mesons in the real electrolyze. Therefore, iridium, gold, osmium, iron and aluminum were found out by the spectrograph in the obtained powder as well except platinum under the anode, made of a platinum wire. The pulse electrolyze

goes more effectively at the increased temperatures without the constant component. Electrolyze should be made preferably on metal or mineral melts from the point of view of atomic power engineering and nuclear metallurgy. Thus it is necessary to change conditions of electrolyze realization. For example, the allowable density of currents at pulse electrolyze can be considerably overestimated.

The summary data of the experiments results are shown in Tabl. 1.

The pulse currents were carried up to 10^6 ampere for mm^2 in the experiments. The electrolyte can be carried up to boiling, but no more. The significant outflow of electrolyte component is possible otherwise. The cryolite Na_3AIF_6 with the additives LiF, CaF_2 and other ones, reducing the temperature of substance melting, was used as electrolyte in the operating thermal reactor, manufactured in the laboratory. The additives of zirconium oxide, titanium sulfide, zinc sulfide and other compositions are introduced for the increase of electrolyte electrical conductivity. The phosphates (for example, aluminum phosphide) are introduced for the increased electrolyte heat emission.

3. Brief operational description of the experimental thermal reactor

3.1. Operational principle

The developed energy generator (in the specific case — thermal) is based on the partial annihilation phenomenon of positive and negative substance discovered and developed by the Bolotovs (B.V. Bolotov, N.A. Bolotova, M.B. Bolotov, I.M. Bolotov). Let's give the description and application of this law in more details.

The Bolotov's law

$$W_\Pi \pm W_H = K_B, \tag{10}$$

where: W_Π is the energy of the positive;
W_Π is the energy of the negative;
K_Π is Bolotov's constant.

The law formulation

"The wave process energy of the positive (W_Π) plus the wave process energy of the negative (W_H) is equal to the conditional permanent constant (K_b)".

The explanatory of the law

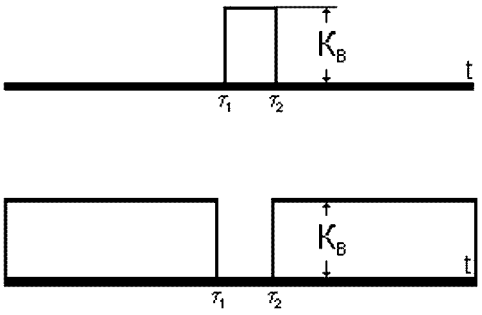

Figure 3: Negativeness and positiveness of time pulses

If to take two photos on a film, one of which is negative, and another is positive, of the same object, combine them with each other on contours and to look at a yawn, so the image on photos will disappear completely. All fields of the negative and positive will be of steady homogeneous darkness, i.e. are determined by the conditional constant K_b.

The overlapping of the positive and negative film images creates as though the annihilation mode of these images, which does not result, however, in significant energy transformations.

If to take the number ρ, which is equal

$$\rho = \frac{1+\sqrt{5}}{2} \tag{11}$$

and involve it into the second degree, so ρ^2 is obtained. Now if the number ρ is deducted of the number ρ^2, so we'll obtain the result equal to 1:

$$\rho^2 - \rho = 1. \tag{12}$$

Having applied these numbers to the Bolotov's law, we shall determine, that the number ρ is positive, and the number ρ^2 is negative, as these numbers' sum or difference is equal to a constant, i.e. a unity. The formula can be defined as the measure of mathematical annihilation. We find out similar in trigonometry as well:

$$\sin^2 x + \cos^2 x = 1. \tag{13}$$

Here the value $\sin^2 x$ is positive, and $\cos^2 x$ is negative. The unity is the Bolotov's constant. The single pulse on a temporary axis is a positive, and the infinite duration pulse of the same amplitude with the interval on a temporary axis is the negative. So these two pulses will give the permanent Bolotovs' constant K_b in the sum on the time axis.

Let's pass to the definition of the substance negativeness and positiveness (Fig. 3).

The matter true elements (MTE), i.e. electrons and π-electrons (positrons), as it was determined in

the work [24] by the authors, form the figures as wave standing and spherical antinodes in the ether. They resemble hollow bubbles, which enlarge up to some sizes and diminish up to zero according to the sinusoid law. In other words, an electron and positron correlate accordingly, as wave expression to the positive and negative. If the positron of one EPR can be combined with the electron of another EPR, so not only mathematical annihilation will take place at $\pi/4$ degrees, when their amplitudes will be equal, but also mutual extinction of both antinodes with the medium perturbation. Electron and positron annihilation can be observed just as it is, and annihilation of larger parts (protons, neutrons, mesons etc.) can be observed harder. Therefore the observation of partial annihilation, which is probable between substances, composing negative and positive components, is real. Indeed, if barium (the element of Mendeleyev's table) can be considered as positive, so krypton will be considered as negative. Really, if barium and krypton can be compressed densely in some volume, so there will be a merge of their nucleons and the uranium element formation. Nitrogen is the negative for boron. Boron annihilates with nitrogen and forms rather strong new elements as well. So the boron and nitrogen combinations form the mineral Borazon, B_2N_2, in which the chrome lines are found out also. Oxygen is the negative for aluminum. The aluminum inclination to annihilation, i.e. to rapprochement with oxygen is so strong, that it takes away oxygen even from iron oxides. We have noticed such aluminum ability in the reaction of aluminum thermal ability, when the oxygen selection from iron oxides is made with energy evolving and silicon formation.

$$Fe_2O_3 + 3Al = Al_2O_3 + Fe + Si + w. \qquad (14)$$

Especially aluminum thermal ability reaction is not stimulated with iron oxide, but zirconium oxide. Then aluminum will be transformed into silicon directly, if there are protons. And the protons occur from neutrons in plenty directly, which leave the zirconium atoms.

$$Zr^{40}_{91} \to Zr^{40}_{40p+51n} \to$$
$$\to Zr^{40} + 51n \to Zr^{40} + 51p + 51e. \qquad (15)$$

The zirconium atom has 51 neutrons, therefore one zirconium atom can give up to 51 protons and the same amount of electrons, which increase the electrolyte electrical conductivity essentially and allow to transform the thermal energy into electrical one with high coefficient of useful action. Thus our power engineering is based on partial annihilation of positive and negative substance limited by frameworks of initial substances and defined in the sphere of electronic interactions. Therefore it is expedient to split the atoms into fine fragments by the pulse device with the purpose to get thermal and electrical energy on the basis of the described phenomena. The neutrons and protons, released during this process, are retarded at the expense of their retarding effect and got heat.

The iron-nickel alloy splitted in the experimental device according to the scheme at pulse currents about 300–500 kA/mm^2:

$$Fe^{26} + Ni^{28} = 2Al^{13} + 2Si^{14} + 4n^0 + w. \qquad (16)$$

Separately both iron and nickel split into two identical parts at the increased current pulses. Iron splits into two aluminum atoms, and nickel splits into two silicon atoms. This remarkable splitting property into two atoms of some even elements of Mendeleyev's table shows, that the natural elements such as iron and nickel represent the molecule similarity in the given example. B.G. Krakow and E.S. Parilis from the Institute of electronics by the Uzbekistan Academy of Sciences [33] called the similar structures of two atoms as quasi-molecules. In other words, iron is represented by the aluminum molecule, i.e. $Fe = Al_2$, nickel is represented by the silicon molecule, i.e. $Ni = Si_2$. These molecules were formed as a result of more dense combination of two atoms, when the atoms are pulled together at the distance about nuclear forces action. The nucleuses of such atoms become double, and sometimes threefold and multiple. Further let's call such atoms as "A Fewatoms." The remarkable property of such atoms is in the opportunity to get and keep additional neutrons by them. Really, for example, the aluminum atom keeps only 14 neutrons, and Fewatoms of aluminum, i.e. the iron atom keeps already 30 neutrons instead of 28. Thus, iron, i.e. the Fewatoms of aluminum can be the nuclear fuel, as the substance giving neutrons during splitting. It is important here to note, that much less energy is required for a Fewatoms splitting into compound fragments, than at their synthesis. Obviously, iron will be the cheapest fuel material for the application in nuclear reactors. Naturally, nuclear reactors can be used with other materials including nickel as well as iron and nickel alloys.

Even atoms frequently split half-and-half at the increased current densities, though this rule is not always carried out. Really, the odd atoms can be splitted into three parts as well, for example, yttrium, which consists of three aluminum atoms $Y^{39}_{89} = 3Al$. Tellurium consists of four aluminum atoms $Te^{52}_{128} = 4Al$. Terbium consists of five atoms $Tb^{65}_{159} = 5Al$. Platinum consists of six aluminum atoms $Pt^{78}_{195} = 6Al$, and proctanium consists of seven aluminum atoms $Pa^{91}_{231} = 7Al$, though other atom combinations are probable as well. The similar picture is observed also at nuclear adhesion of silicon atoms. So two silicon atoms form nickel $Ni^{28}_{59} = 2Si$. It was proved by the authors experimentally. Three silicon atoms form molybdenum $Mo^{42}_{96} = 3Si$. It was proved by the authors experimentally as well. Four silicon atoms, perhaps, form barium

$Ba^{56}_{137} = 4Si$, five atoms can form ytterbium $Yb^{70}_{173} = 5Si$, six atoms can form polonium $Po^{84}_{209} = 6Si$ and so on.

Aluminosilicates dominate on the globe. Perhaps, aluminum and silicon are more stable elements and, finally, all the elements of Mendeleyev's table are formed of aluminum, silicon and these element fraction combinations. As it was shown earlier, that there is iron and nickel elements splitting into aluminum and silicon at current pulses at the first moment of time. But fraction adhesion with each other is observed after the current cancellation action. For example, the silicon, obtained during nickel division, joins again to nickel, forming molybdenum according to the scheme:

$$Ni^{28}_{59} + Si^{14}_{29} = Mo^{42}_{88}. \tag{17}$$

This molybdenum differs from natural one by neutron shortage, but the partially released neutrons increase the number of molybdenum nucleons according to the scheme Eq. (16).

The neutron amount can be increased at the expense of heavier atoms splitting, for example, barium or zirconium. Here barium can be splitted into two-nickel atoms at pulse currents, which will be splitted into silicon according to the scheme:

$$Ba^{56}_{137} = 2Ni^{28}_{59} + 19n^0 = 4Si^{14}_{28} + 25n^0. \tag{18}$$

Thus, one barium atom can give up to 25 neutrons at splitting. Knowing, that iron represents aluminum atoms, adhering in pairs, aluminum thermal ability can be explained rather beautifully as well. Really, if to present the aluminum atomic and molecular aluminum mixture, i.e. adhering in pairs, so the oxygen will combine to atomic aluminum preferably.

The similar nuclear reactions were carried out also repeatedly in our experiments together with nuclear engineers of Slovakia.

It is possible to tell at the end of the work, that controlled nuclear reactions especially the splitting into fragments are finally confirmed by numerous spectrograph researches at the laboratory of Myroslav Kollar with his direct participation in numerous experiments. And it was possible to find out the large atoms splitting mainly into aluminum, silicon, calcium attracting the outstanding scientists of Slovakia as well as the first stage in controlled atomic power engineering is finished along with them. The choice of substances will be the second stage, at which it is possible to obtain the maximum neutrons level at a rather cheap used material. There will be an improvement of the basic schemes of laboratory models at the third stage, and the improvement of the experimental sample at the fourth stage.

3.2. Experimental researches

The experimental researches were carried out on the operating unit (Fig. 4). It represents the induction furnace working with additional coils W_1 and W_2, wired in regular intervals onto a tore-like framework with windows for the tore cavity inputting inside of the tested samples (TS), placed into refractory zirconium or graphite crucibles.

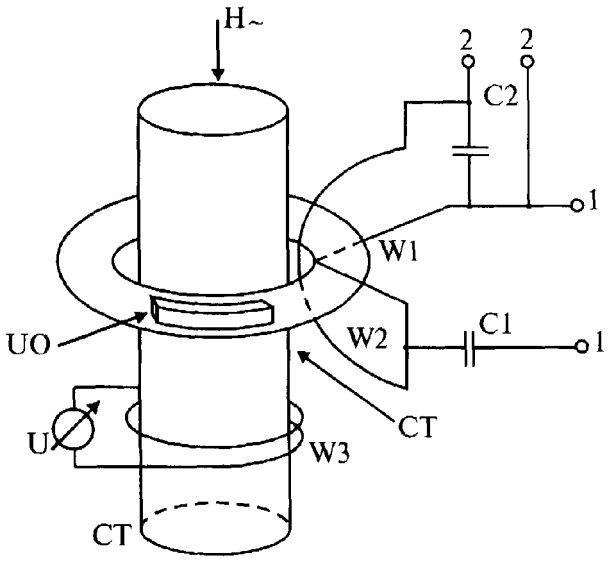

Figure 4: The scheme of the experimental unit

The coils W_1 and W_2 have identical number of windings, but they have various wire gages. As these coils are counter-connected, so their common inductance is very small. If a wire gage of one coil can be taken equal to 0.1 of another coil, so the resulting ampere-windings will decrease only in 10%. But the necessary induction vortex currents through the tested samples can be got at frequencies about 300 MHz. Powder-like ferrite substance is placed for a magnetic induction and magnetic field increase onto the tested sample into the space of a tore-like magnetic circuit.

The spectrogram of initial data or tested substances was taken off during the unit operation. Some unit parameters were taken off by the indicator (U), connected to the winding W_3 put on a core (CT), which could be made of the same substance, as the tested sample. Generally the CT core material is the stippler of transformer iron, or iron-nickel alloy, the magnetic flow in which induces longitudinal current in a ring in the tested sample. In some cases the density value of pulse current reached up to 10^7 A/mm^2. Though there is, as a rule, the melt evaporation at the expense of abnormal thermal energy release at such current densities, so the currents as short pulses (up to 0.1 μs) are supplied to primary coils. There is the constant magnetization in the circuit 2 — 2 in the unit. The windings W_1 and W_2 appear plugged in according to (consecutively) for it. The nuclear substance reconstruct was managed to find out with the described experimental unit.

The pulse currents of density 10^7 A/mm^2 with the

pulse duration of ~ 0.1 μs were passed through cobalt melt in one of the experiments. The weak neutron background was created additionally. The frequency of pulses consequence was limited to the bath average temperature, which was retained at the level 2500°C. The spectrograms were taken off and compared with initial ones in ten operating hours of the unit. The spectrograph ICП-22/28 discovered the lines 2407.3 Å; 2411.6 Å; 2424.9 Å; 2589.7 Å; 3044.0 Å; 3405.1 Å; 3412.3 Å; 3449.4 Å; 3453.5 Å and 2414.5 Å, which cobalt has, before current feed.

The frequency 2589.7 Å shifted to the line site 2599.39 Å after the pulse current feed. The frequency 3044.0 Å shifted to the site 3020.64 Å. All of them belong to iron. The frequency 3050.8 Å has appeared near the frequency 3044.0 Å. The frequency 3414.7 Å has appeared near the frequency 3412.3 Å. New frequency 2943.9 Å also has appeared. All of them belong to nickel. Here it should be noted, that both iron and nickel are separately splitted half-and-half. The iron is splitted into two aluminum atoms, and nickel is splitted into two silicon atoms. Thus both iron and nickel throw out two neutrons while splitting. Therefore both iron and nickel can be called as quasimolecules in our example, i.e. two aluminum and silicon atoms are pulled together as pairs at the distance about nuclear forces action, at which they are united firmly by nuclear forces capable to attach neutrons. The reactions go well at a small irradiation by neutrons or protons though their submission is unessential. They promote the occurrence of powerful chain processes and formation of additional neutrons at the expense of quasimolecules splitting. Despite of small neutron energy, participating in reaction, it is necessary, on one hand, to put neutron reflectors (for example, zirconium ones), and on the other hand — it is necessary to be shielded from them simply. These neutrons are thermal and have rather small velocities in its movement. We used bronze rings with the thickness up to 100 mm in the experimental unit, which were cooled by water.

The similar nuclear reaction goes in borazon B_2N_2 as well. The constant current is passed with deuterium or tritium for borazon saturation, "driving" hydrogen ions into a crystal lattice of boron azide. Then it is necessary to pass current pulses of the density about 10^6 A/ mm^2 through it. It is necessary also to supply a small level of extraneous neutrons though the nuclear processes go even at the current density less than 10^5 A/mm^2 without additional neutrons for the reaction beginning. Borazon should have some critical mass and is surrounded with zirconium reflectors. Beryllium and carbon were found out after the pulse current passing in the tested samples.

The vikalloy alloy was made of 51% Co, 11% V, 37% Fe, well cleared from impurity, for one of the experiments. The spectrogram was taken off from the experimental sample after melting. The chrome lines 2986.47 Å, 2905.5 Å (near to the cobalt line 3044.0 Å) were found out except for the lines of cobalt, vanadium and iron. The vanadium lines 2682.9 Å and 2683.1 Å shifted to the site 2663 Å, specific for chrome. Though the chrome line 2686.57 Å was formed of the iron line 2990.4 Å. The new chrome frequencies, such as: 2843.25 Å, 2860.9 Å, 2849.8 Å, 2835.6 Å have appeared. The silicon and magnum frequencies were found out as well. However chrome, just as it is, as silicon and magnum, was not subjected to separation.

3.3. Theoretical substantiation

The basic theoretical rules, which explain the carried out experiments, are given in the work [24]. The paired cobalt atoms can be transformed by the hydrogen nucleus throwing over from one cobalt atom to another according to the scheme:

$$
\begin{aligned}
{}^{59}_{27}Co \rightarrow {}^{3,2,1}_{1}H \rightarrow {}^{59}_{27}Co = \\
= {}^{56,57,58}_{26}Fe + {}^{60,61,62}_{28}Ni + w, \qquad (19)
\end{aligned}
$$

where w is the released energy, which is calculated according to the formula [24, p. 53.]

$$
\begin{aligned}
w = 2W_{Co} - W_{Fe} - W_{Ni} = \\
= 2 \cdot 18.649 - 15.707 - 19.123 \approx 2.5 \text{ MeV}. \qquad (20)
\end{aligned}
$$

The reaction Eq. (19) is convertible, and, if the current pulses (up to $10^{4\ldots7}$ A/mm^2, the duration about 0.1 μsec) can be passed through iron and nickel melts, therefore there are frequencies of cobalt, aluminum, silicon and molybdenum in iron and nickel spectrograms. Naturally, the reverse reaction goes with the energy absorption though many neutrons are formed from iron and nickel decomposition into aluminum and silicon, which give a lot of thermal energy at the expense of their retarding action.

It was noticed, that cobalt turned not into the pure iron at the hydrogen atom splitting off from it, but into a cluster (the combination of silicon and magnum ion), though the iron can be formed of two aluminum atoms direct pairing. We have called it as iron izostere, and as a matter of fact iron is a quasimolecule, because its spectral lines have coincided with the spectral lines of iron, magnum, silicon and aluminum.

It was assumed studying the character of experiments, that ferromagnetism and superconductivity have much in common. The superconductivity is the basis in them. In other words, ferromagnetic is the alloy of superconductive substances with usual conductivity. Really, if to address to chemical elements with the number, multiple to the number 9, that is F, Ar, Co, Kr, Rh, Xe, the elements F, Ar, Kr and Xe are gases. Cobalt and rhodium are metals. Let's consider a cobalt atom. It can be presented as three atoms

of fluorine, or as one fluorine atom and one argon atom. Really, cobalt, being in the group of manganese, iron, nickel, copper and others, has strong metal properties. In other words, cobalt combines the properties of two substance states simultaneously: metallized gases and metals.

The inert gases Ar, Kr, Xe, having small ionization potentials (are less, than He and Ne, and also the series of alkaline elements), become as their strong oxidizers, for example XeF_8, XeO_4, $XeOF_6$. Cobalt, having the same combinations as noble gases KrF_2, XeF_2 — CoF_2; KrF_4, XeF_4 — CoF_4, CoO_4 etc., obtains the similar properties as well. But the key thing means here that cobalt creates the superconductive domains and undergoes the nuclear transformations such as hydrogen atoms throwing over in the interaction with other elements.

There can be such explanation for iron transformation. It is noticed in the experiments, that iron clusters will be transformed easily into krypton clusters (or krypton izosteres) at chrome ions available according to the scheme:

$$^{56}_{26}Fe - ^{4}_{2}H = ^{52}_{24}Cr = ^{54}_{26}Al_2. \tag{21}$$

But, the formed chrome is the cluster of magnum ion and atom as itself, so the cluster of double krypton is formed of 3 chrome clusters

$$3^{52}_{24}Cr = 2^{78}_{36}Kr. \tag{22}$$

Thus, the superconductive element is not the other, as krypton cluster, at which gas component is metallized. It allows explaining the experiment with the vikalloy alloy. Their interaction formula will be as follows taking into account the percentage of the alloy elements

$$51^{59}_{27}Co + 11^{51}_{23}V + 37^{56}_{26}Fe = 36(^{78}_{36}Kr)_2 + 26n^0 + w. \tag{23}$$

Here 26 "redundant" neutrons will be placed among krypton clusters in such a way, that the neutron release will be negligibly small at vikalloy alloying. The energy w will be positive due to the fact that the krypton clusters $^{78}_{36}Kr$ are denser, than separately Co, V, Fe.

The superconductivity of the krypton clusters at room temperature is determined according to the huge diamagnetism of separate domains with paramagnetic domains of iron and cobalt included.

There is 0.4% of cobalt, 6% of tungsten, 93.6% of iron in a tungsten magnet ($H_C = 5200$ A/m, $B = 1.05$ Tl). As the superconductive domains are formed by krypton clusters in such a magnet, so their calculation in the combination will be:

$$Co_{0.4} + W_6 + Fe_{93.6} = Kr_{79.8} + w \tag{24}$$

or

$$4^{59}_{27}Co + 60^{184}_{74}W + 936^{56}_{26}Fe = \\ = 399^{80}_{36}Kr + 1112n^0 + w. \tag{25}$$

Here the redundant neutrons will be placed among the krypton clusters.

The obtained alloy has a hexagonal structure. Therefore, the hexahedron construction goes from the cobalt germ, surrounded by five tungsten atoms on the first layer and fourteen tungsten atoms on the second layer [24]. It is obvious, that on the ninth layer, seven of which are the atoms of iron, the growth of an elementary crystal-cluster terminates. There is one cobalt atom, 19 tungsten atoms and 256 iron atoms on the ninth layer. Hence, the formula Eq. (25) should be correctly written down as:

$$4^{59}_{27}Co + 76^{184}_{74}W + 1064^{56}_{26}Fe = \\ = 458(^{80}_{36}Kr)_2 + 300n^0 + w$$

or

$$^{59}_{27}Co + 19^{184}_{74}W + 265^{56}_{26}Fe = \\ = 229^{80}_{36}Kr + 75n^0 + w. \tag{26}$$

Accordingly, the percentage of the vikalloy alloy should be the following: Co — 0.35%, W — 6.66%, Fe — 92.99%. These small changes increase the magnetic field energy almost twice. The reactions in borazon can be explained as follows. Tritium atoms will split into fragments (2 neutrons, 1 proton, 1 electron) under the action of pulse currents and exited neutrons

$$^{3}_{1}H = 2n^0 + p + e. \tag{27}$$

The explosive process of tritium splitting can result in one hydrogen atom excess or its proton excess from a boron nucleus, or from a nitrogen nucleus. Thus both atoms of carbon, as well as beryllium and oxygen atoms can be formed. The reactions go, obviously, according to the schemes:

$$^{11}_{5}B \rightarrow ^{2,1}_{1}H \rightarrow ^{15}_{7}N = ^{9,10}_{4}Be + ^{16,17}_{8}O + w_1; \tag{28}$$

$$^{14}_{7}N \rightarrow ^{2,1}_{1}H + ^{11}_{5}B = 2^{12,13}_{6}C + w_2, \tag{29}$$

where

$$w_1 = W_B + W_N - W_{Be} - W_O = \\ = 3.181 + 4.167 - 2.504 - 4.55 = 0.294 \text{ MeV};$$

$$w_2 = W_N + W_B - 2W_C = \\ = 3.181 + 4.167 - 2(3.029) = 1.29 \text{ MeV}.$$

Both reactions go with the energy release. If graphite can be sated with deuterium and tritium, as well as the above mentioned pulse currents can be passed through it, so the nuclear reaction Eq. (29) can go partially in the opposite direction.

References

[1] B.V. Bolotov, "Electrolyze effects by a pulse current without a constant component, edition." *A wood Industry, col. of papers UkrNIIB* (Kiev), No. 19, 1976, p. 135–144.

[2] B.V. Bolotov, N.A. Goryachuk, M.B. Bolotov, "The phenomenon of pseudo-nuclear transformation in ferromagnetic substances." The application for discovery OT-EB-211 on March 10, 1989.

[3] M.B. Bolotov, N.A. Goryachuk, B.V. Bolotov, S.S. Shchelkanov, "The way of boron transformation and the device for its realization." The application No. 4734708/ 25 (79840) on June 9, 1989.

[4] B.V. Bolotov, "The effect of irreversible interrelation of a magnetic field in weakly connected superconductors." The application No. 32-OT-5011 on February 28, 1966, reapplied according to the application No. 32-OT-9380 on October 8, 1970 and applied in the application No. 668811/31 on June 2, 1960 — "The method of the device construction for visual research of alive organisms in infra-red beams."

[5] M.B. Bolotov, N.A. Goryachuk, B.V. Bolotov, S.S. Shchelkanov, "The way of nuclear metals processing." The application No. 4705519/25 (54888) on April 1, 1988.

[6] B.V. Bolotov, "The way of particles acceleration and the information transfer." The application No. 754747/26 on December 7, 1961.

[7] B.V. Bolotov, "The law of a magnetic circuit." The application No. 32-OT-2343 on June 17, 1962.

[8] B.V. Bolotov, N.A. Goryachuk, M.B. Bolotov, The additions to the application No. 32-OT-2373 on June 27, 1962 for the law of ferromagnetic radiation.

[9] B.V. Bolotov, V.F. Kaluzhny, "The effect of chain reaction in a ferromagnetic substance." The application No. 32-OT-3322 and No. 32-OT-4553 on September 27, 1963.

[10] B.V. Bolotov, "The substantiation of the ferromagnetism phenomenon." The application No. 32-OT-3500 on January 14, 1964.

[11] M.B. Bolotov, N.A. Goryachuk, B.V. Bolotov, The additions to the application No. 32-OT-3500 on January 14, 1964 for the substantiation of the ferromagnetism phenomenon.

[12] B.V. Bolotov, N.A. Ivakhnenko, "Magnetic multipliers." *Automatics*, No 1, Kiev, 1968, p. 70–73.

[13] B.V. Bolotov, "On the definition of some ratio in magnetic analog regulating and remembering devices." In the collection "Problems of technical electrodynamics," No. 19, 1969, p. 109–116.

[14] B.V. Bolotov, A.A. Telyatnik, "Ferromagnetism is one of the accuracy increase opportunities of geodetic observations during orientation," col. "Engineering researches in construction. Geological, hydrological and geophysical methods." Kiev, Budivelnyk, 1975, p. 22.

[15] B.V. Bolotov, N.A. Goryachuk, M.B. Bolotov, "The effect of influence independence of magnetic dipoles." The addition to the application No. 32-OT-5777 on March 28, 1967.

[16] B.V. Bolotov, "The electrolyze way with an alternating current of the asymmetric form without a constant component." The application No. 1630790/02 (027312 Rc) on March 9, 1971.

[17] M.B. Bolotov, N.A. Goryachuk, B.V. Bolotov, S.S. Shchelkanov, "Molybdenum izostere derivatives and the way of their obtaining." The application No. 474687/25 (106470) on August 2, 1989.

[18] M.B. Bolotov, N.A. Goryachuk, B.V. Bolotov, S.S. Shchelkanov, "The way of cold nuclear synthesis." The application No. 4739016/25 (97438), on July 14, 1989.

[19] M.B. Bolotov, N.A. Goryachuk, B.V. Bolotov, S.S. Shchelkanov, "The way of thermonuclear substance transformation." The application No. 4719432/25 (099628) on July 7, 1989.

[20] B.V. Bolotov, M.B. Bolotov, N.A. Goryachuk, "The Phenomenon of the chain reaction in alloys," No. OT-EП-627/51 on November 10, 1989.

[21] B.V. Bolotov, N.A. Bolotova, M.B. Bolotov, "Physical and chemical table of izosteres," Ukrainian Academy of Original Ideas, the idea No. 4, Kiev, 1994.

[22] B.V. Bolotov, "Ferromagnetic remembering device," Auth. cert. No. 788112, bul. No. 46 on December 15, 1980 according to the application No. 861816/18-24 on October 19, 1963.

[23] B.V. Bolotov, V.F. Kaluzhny, "Mechanical noise source of energy," the application for the invention No. 783247/26-9 on June 18, 1962.

[24] B.V. Bolotov, N.A. Bolotova, M.B. Bolotov, "Fundamentals of a substance structure," Zaporozhye, Press of ZSIA, 1996, 110 pp.

[25] V.V. Krimsky, V.F. Balakirev, "Influence of nanosecond electromagnetic pulses on substances properties." The reports of the Academy of Sciences, Physical chemistry on May 8, 2002, v. 385, No. 6, p. 786–787.

[26] L.I. Urutskoev and others, "Experimental detection of the "strange" radiation and transformations of chemical elements." Moscow, Russia, Kurchatov Institute, "REKOM" RNC, Applied physics, 4, 2000, p. 83–99.

[27] N.I. Ivanov, A.V. Vachaev, G.A. Pavlova, L.A. Skvortsov, "The Basic rules of deuteron mine-metallurgical technology," *Izvestiya VUZOV, Black Metallurgy*, 4, 1998, Magnitogorsk.

[28] N.E. Zilberman, I.I. Polzikova, A.O. Rayevsky, "Z-exchange resistive mechanism of spin waves amplification in ferromagnetic semiconductors in the high-frequency electrical field." *Letters to GETF*, v. 50, publ. 6, p. 284–286.

[29] B.V. Bolotov, M.B. Bolotov, N.A. Bolotova, "The Phenomenon of hydrogen atoms emission under the electron affect." No. 51-13-57/ЕП, К - 2572 on October 12, 1988.

[30] B.V. Bolotov, "The effect of irreversible interrelation in electromagnetic fields," No. 32-OT-5011 on February 16, 1966.

[31] B.V. Bolotov, M.B. Bolotov, N.A. Goryachuk, "The Phenomenon of hydrogen atoms emission under the photon affect," No. OT-ЕП-642/51 on April 7, 1989.

[32] M. Fleshman, S. Pounce, "Electrochemically induced nuclear synthesis of deuterium," *J. Electroanal. Chem.*, 1989, v. 261, No. 2a, p. 301–308.

[33] B.G. Krakow, E.S. Parilis, "Quasimolecules," *Uspechi Fizicheskich Nauk, sciences*, v. 157, publ. 3, March, 1989, p. 477–510.

[34] B.V. Bolotov, N.A. Bolotova, M.B. Bolotov, "The Physicochemical Table of a Matter Structure," *Spacetime & Substance*, **4**, 1, 7–21 (2003).

[35] B.V. Bolotov, N.A. Bolotova, M.B. Bolotov, "Nuclear Conversions in Low Energies," *Spacetime & Substance*, **4**, 2, 58–66 (2003).

[36] B.V. Bolotov, "Photonuclear and Betanuclear Synthesis in an Alive Nature," *Spacetime & Substance*, **4**, 3, 103–113 (2003).

Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 164–168

SYMMETRIES IN HÉNON-HEILES' TWO-BODY PROBLEM

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Received September 18, 2003

We examine the symmetries exhibited by the vector field corresponding to the two-body problem associated to Hénon-Heiles' model. In both configuration-momentum and polar coordinates, and in collision-blow-up and infinity blow-up McGehee-type coordinates, these symmetries form four-element groups isomorphic to Klein's group. In Levi-Civita collision-blow-up coordinates, the vector field has an eight-element Abelian group, with idempotent structure, owning seven four-element proper subgroups, also isomorphic to Klein's group. All these symmetries are of much help, especially in finding periodic orbits, in both genuine or perturbed two-body problems, or in more general problems as regards the number of bodies.

1. Introduction

One of the most celebrated potentials in astronomy is Hénon-Heiles' (1964) one, primarily intended to model the motion of a star into a galaxy. In the two-body problem associated to this potential, it reads

$$U(\mathbf{q}) = \mathbf{A}\mathbf{q}_1^2 + \mathbf{B}\mathbf{q}_2^2 + \mathbf{C}\mathbf{q}_1^2\mathbf{q}_2 + \mathbf{D}\mathbf{q}_2^3, \qquad (1)$$

where $\mathbf{q} = (\mathbf{q_1}, \mathbf{q_2}) \in \mathbb{R}^{\not\vdash}$ is the position (configuration) vector of one particle with respect to another, whereas $A, B, C, D \in \mathbb{R}$ $(A, B > 0)$ are real parameters.

Mioc and Barbosu (2003) tackled the collision dynamics in such a problem, describing the so-called *collision manifold* obtained via McGehee-type transformations of the second kind (McGehee 1974). In this paper we approach the same problem from a unique standpoint: symmetries.

Section 2 points out the symmetries exhibited by the vector field of the problem expressed in configuration-momentum coordinates. These symmetries form a four-element Abelian group endowed with an idempotent structure. Section 3 transposes the problem in standard polar coordinates. A wholly analogous group of symmetries is found.

Section 4 examines the regularized vector field obtained via collision-blow-up McGehee-type transformations (Mioc and Barbosu 2003). A four-element-group, analogous to the previous ones, is retrieved.

In Section 5, infinity-blow-up McGehee-type coordinates are used to investigate the motion when the distance between particles tend to infinity in the future/past (escape/capture). Using McGehee-type transformations of both first and second kind (McGehee 1973, 1974), we get a regular vector field that presents a four-element group of symmetries, wholly analogous to the previous ones.

Just for comparison purposes, in Section 6 we resort to Levi-Civita regularizing transformations (Levi-Civita 1904). The vector field we obtain exhibits symmetries that form an eight-element Abelian group endowed with an idempotent structure.

Section 7 emphasizes the main results of the paper. All four-element groups are isomorphic to Klein's group. This is not a trivial result, because the phase spaces corresponding to the collision-blow-up McGehee-type coordinates and the infinity-blow-up McGehee-type coordinates contain supplementary boundary manifolds: the collision manifold and the infinity manifold. As to the eight-element group of symmetries corresponding to Levi-Civita coordinates, it owns seven four-element proper subgroups, each one being isomorphic to Klein's group.

All symmetries emphasized in this paper are of much help especially in finding periodic orbits, in both general or concrete two-body problems associated to Hénon-Heiles' model, or in more general problems as regards the number of bodies.

2. Symmetries in configuration-momentum coordinates

Consider the planar motion of a unit-mass particle with respect to the field-generating source. The mo-

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tion equations are

$$\begin{aligned} \dot{\mathbf{q}} &= \partial H(\mathbf{q},\mathbf{p})/\partial \mathbf{p}, \\ \dot{\mathbf{p}} &= -\partial H(\mathbf{q},\mathbf{p})/\partial \mathbf{q}, \end{aligned} \tag{2}$$

in which $\mathbf{q} = (\mathbf{q_1}, \mathbf{q_2}) \in \mathbb{R}^{\not 4}$ and $\mathbf{p}(= \dot{\mathbf{q}}) = (\mathbf{p_1}, \mathbf{p_2}) \in \mathbb{R}^{\not 4}$ are, respectively, the position (configuration) vector and the momentum vector of the particle. The Hamiltonian of the problem reads $H(\mathbf{q},\mathbf{p}) = \mathbf{T}(\mathbf{p}) - \mathbf{U}(\mathbf{q})$, where $T(\mathbf{p}) = |\mathbf{p}|^{\mathbf{2}}/\mathbf{2}$ is the kinetic energy, whereas $-U(\mathbf{q})$, given by (1), is the potential energy.

Explicitly, the equations of motion read

$$\begin{aligned} \dot{q}_1 &= p_1, \\ \dot{q}_2 &= p_2, \\ \dot{p}_1 &= 2Aq_1 + 2Cq_1q_2, \\ \dot{p}_2 &= Cq_1^2 + 2Bq_2 + 3Dq_2^2. \end{aligned} \tag{3}$$

Remark 2.1. As shown by Mioc and Barbosu (2003), equations (3) admit the first integral of energy $H(\mathbf{q},\mathbf{p}) = \mathbf{h}$, where h stands for the energy constant. As to the angular momentum, this one is not conserved, given the anisotropic structure of the potential.

Proposition 2.2. *The vector field (3) benefits of four remarkable symmetries,* $s_i = s_i(q_1, q_2, p_1, p_2, t)$, $i = \overline{0,3}$, *as follows:*

$$\begin{aligned} s_0 &= (q_1, q_2, p_1, p_2, t) = I \text{ (identity)}, \\ s_1 &= (q_1, q_2, -p_1, p_2, -t), \\ s_2 &= (-q_1, q_2, -p_1, p_2, t), \\ s_3 &= (-q_1, q_2, p_1, -p_2, -t). \end{aligned} \tag{4}$$

Proof. One sees immediately that equations (3) are invariant to the transformations described by (4). □

Proposition 2.3. *Out of the symmetries* s_i, $i = \overline{1,3}$, *only two are independent.*

Proof. By (4), we have $s_3 = s_1 \circ s_2$, $s_2 = s_1 \circ s_3$, $s_1 = s_2 \circ s_3$. □

Theorem 2.4. *The set* $G = \{s_i |\ i = \overline{0,3}\}$, *endowed with the composition law "*$\circ$*", forms a symmetric Abelian group with an idempotent structure.*

Proof. The composition table below

$\circ$	s_0	s_1	s_2	s_3
s_0	s_0	s_1	s_2	s_3
s_1	s_1	s_0	s_3	s_2
s_2	s_2	s_3	s_0	s_1
s_3	s_3	s_2	s_1	s_0

can be easily constructed and checked. The Abelian character is obvious. As regards the idempotent structure, it is clear that every element is its own inverse with respect to the composition law. □

Remark 2.5. By (4), one sees that there are no symmetry with respect to the q_1-axis, but only with respect to the q_2-axis. This is due to the anisotropy of Hénon-Heiles' field.

3. Symmetries in polar coordinates

Given the anisotropy, we transpose the problem in polar coordinates via the transformations (Mioc and Barbosu 2003):

$$\begin{aligned} r &= |\mathbf{q}|, \quad \theta = \arctan(\mathbf{q_2}/\mathbf{q_1}), \\ u &= \dot{r} = (q_1p_1 + q_2p_2)/|\mathbf{q}|, \\ v &= r\dot{\theta} = (q_1p_2 - q_2p_1)/|\mathbf{q}|, \end{aligned} \tag{5}$$

which make the motion equations (3) read

$$\begin{aligned} \dot{r} &= u, \quad \dot{\theta} = v/r \\ \dot{u} &= v^2/r + (2A + 3Cr\sin\theta)r\cos^2\theta + \\ &\quad + (2B + 3Dr\sin\theta)r\sin^2\theta, \\ \dot{v} &= -uv/r + 2(B - A)r\sin\theta\cos\theta + \\ &\quad + [3(D - C)\sin^2\theta + C]r^2\cos\theta. \end{aligned} \tag{6}$$

Proposition 3.1. *The vector field (6) also benefits of four symmetries,* $s_i^{pol} = s_i^{pol}(r, \theta, u, v, t)$, $i = \overline{0,3}$, *as follows:*

$$\begin{aligned} s_0^{pol} &= (r, \theta, u, v, t) = I^{pol} \text{ (identity)}, \\ s_1^{pol} &= (r, \theta, -u, -v, -t), \\ s_2^{pol} &= (r, \pi - \theta, -u, v, -t), \\ s_3^{pol} &= (r, \pi - \theta, u, -v, t). \end{aligned} \tag{7}$$

Proof. One can easily check that equations (6) are invariant to the transformations (7). □

Let us see what symmetries (7) mean from a physical standpoint. Considering separately each argument of s_i^{pol}, $(t, -t)$ means motion in the future/past; $(u, -u)$ signifies outwards/inwards motion; $(v, -v)$ means clockwards/counterclockwards motion; finally, $(\theta, \pi - \theta)$ signifies symmetric positions on the trigonometric circle with respect to the axis $\theta = \dfrac{(2n+1)\pi}{2}$, $n \in \mathbb{Z}$. As to their combination into symmetries, s_1^{pol} corresponds to the reversibility of the flow: for each orbit there is another orbit with the same coordinates and with inverse velocities, all in reversed time; and so on.

Proposition 3.2. *Out of the symmetries* s_i^{pol}, $i = \overline{1,3}$, *only two are independent.*

Proof. By (7), we have $s_3^{pol} = s_1^{pol} \circ s_2^{pol}$, $s_2^{pol} = s_1^{pol} \circ s_3^{pol}$, $s_1^{pol} = s_2^{pol} \circ s_3^{pol}$. □

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

Proof. Imitating the proof given to Theorem 2.4, the stated results are obtained. □

Remark 3.4. By (7), one sees that only symmetries with respect to the vertical axis of the trigonometric circle do exist. This corroborates Remark 2.5.

4. Symmetries in collision-blow-up coordinates

To remove the isolated singularity equations (6) present at the origin ($r = 0$), we resort to the dynamical variable transformation $ds = r^{-1}dt$. In this way, the vector field (6) acquires the form

$$\begin{aligned} &r' = ru, \quad \theta' = v, \\ &u' = v^2 + (2A + 3Cr\sin\theta)r^2\cos^2\theta + \\ &\qquad +(2B + 3Dr\sin\theta)r^2\sin^2\theta, \\ &v' = -uv + 2(B - A)r^2\sin\theta\cos\theta + \\ &\qquad +[3(D - C)\sin^2\theta + C]r^3\cos\theta, \end{aligned} \tag{8}$$

where $(\cdot)' = d(\cdot)/ds$, and we kept, by abuse, the same notation for the new functions of the timelike variable s.

Remark 4.1. The motion equations are now regular. The phase space was analytically extended to the boundary $r = 0$, which is invariant to the flow ($r' = 0$ for $r = 0$). The singularity was replaced by the (boundary) collision manifold, whose structure was described by Mioc and Barbosu (2003).

Remark 4.2. In fact, the transformations (5) and the time rescaling also are steps of collision-blow-up McGehee-type transformations (McGehee 1974).

Proposition 4.3. *The vector field (8) also benefits of four symmetries,* $s_i^c = s_i^c(r, \theta, u, v, s)$, $i = \overline{0,3}$, *wholly similar to (7).*

Proof. Let us formally write $s_i^c(r, \theta, u, v, s) = s_i^{pol}(r, \theta, u, v, t)$, $i = \overline{0,3}$. The statement becomes obvious. □

With this, the following results can be stated without proof:

Proposition 4.4. *Out of the symmetries* s_i^c, $i = \overline{0,3}$, *only two are independent.*

Theorem 4.5. *The set* $G^c = \{s_i^c |\ i = \overline{0,3}\}$, *endowed with the composition law "$\circ$", forms a symmetric Abelian group with an idempotent structure.*

5. Symmetries in infinity-blow-up coordinates

Another limit situation is the escape/capture ($r \to \infty$ in the future/past). To obtain the motion equations in this case, we start from (5) and use the following sequence of McGehee-type transformations of the first and second kind (McGehee 1973, 1974):

$$\rho = r^{-1}; \tag{9}$$

$$\xi = u\rho^{3/2}, \quad \eta = v\rho^{3/2}; \tag{10}$$

$$d\tau = \rho^{-1/2}dt. \tag{11}$$

Remark 5.1. The transformation (9) brings the infinity at the origin, turning it to a singularity. The transformations (10) and (11) blow up this singularity, as in the case of collision.

Under transformations (9)-(11), the vector field (5) becomes

$$\begin{aligned} &d\rho/d\tau = -\rho\xi, \quad d\theta/d\tau = \eta, \\ &d\xi/d\tau = -\frac{3}{2}\xi^2 + \eta^2 + (2A\rho + 3C\sin\theta)\times \\ &\qquad \times\cos^2\theta + (2B\rho + 3D\sin\theta)\sin^2\theta, \\ &d\eta/d\tau = -\frac{5}{2}\xi\eta + 2(B - A)\rho\sin\theta\cos\theta + \\ &\qquad +[3(D - C)\sin^2\theta + C]\cos\theta, \end{aligned} \tag{12}$$

where we kept, by abuse, the same notation for the new functions of the timelike variable τ.

Remark 5.2. Equations (12) are regular. The phase space was analytically extended to the boundary $\rho = 0$, which is invariant to the flow ($\rho = 0$ for $\rho = 0$). The singularity was replaced by the (boundary) infinity manifold, whose structure (much more intricate than the one of M_c) will be described elsewhere.

To point out the symmetries that characterize the vector field (12), let us formally write $s_i^\infty(\rho, \theta, \xi, \eta, \tau) = s_i^c(r, \theta, u, v, t)$, $i = \overline{0,3}$. We can state without proof:

Proposition 5.3. *The vector field (12) also benefits of four symmetries,* $s_i^\infty = s_i^\infty(\rho, \theta, \xi, \eta, \tau)$, $i = \overline{0,3}$, *wholly similar to (7).*

Proposition 5.4. *Out of the symmetries* s_i^∞, $i = \overline{0,3}$, *only two are independent.*

Theorem 5.5. *The set* $G^\infty = \{s_i^\infty |\ i = \overline{0,3}\}$, *endowed with the composition law "$\circ$", forms a symmetric Abelian group with an idempotent structure.*

Remark 3.4 is also retrieved in these coordinates.

6. Symmetries in Levi-Civita coordinates

So far, to avoid singularities, we resorted to McGehee-type transformations. But there is a lot of regularizing transformations we could use. In the sequel, just for comparison purposes, we shall apply Levi-Civita's transformations

$$r = z^2, \quad \dot{r} = w/z, \quad \dot{\theta} = \varphi; \qquad d\sigma = z^{-3}dt \tag{13}$$

to equations (6). The respective vector field turns to

$$\begin{aligned} &dz/d\sigma = wz/2, \quad d\theta/d\sigma = \varphi z^3, \\ &dw/d\sigma = \varphi^2 z^6 + (2A + 3Cz^2\sin\theta)z^6\cos^2\theta + \\ &\qquad +(2B + 3Dz^2\sin\theta)z^6\sin^2\theta + w^2/2, \\ &d\varphi/d\sigma = -2w\varphi + 2(B - A)z^3\sin\theta\cos\theta + \\ &\qquad +[3(D - C)\sin^2\theta + C]z^5\cos\theta, \end{aligned} \tag{14}$$

where we kept, by abuse, the notation for the new functions of the timelike variable σ.

Proposition 6.1. *The vector field (14) has eight symmetries, $s_i^{LC} = s_i^{LC}(z, \theta, w, \varphi, \sigma)$, $i = \overline{0,7}$, as follows:*

$$\begin{aligned} s_0^{LC} &= (z, \theta, w, \varphi, \sigma) = I^{LC} \text{ (identity)}, \\ s_1^{LC} &= (z, \theta, -w, -\varphi, -\sigma), \\ s_2^{LC} &= (z, \pi - \theta, w, -\varphi, \sigma), \\ s_3^{LC} &= (-z, \theta, -w, \varphi, -\sigma), \\ s_4^{LC} &= (z, \pi - \theta, -w, \varphi, -\sigma), \\ s_5^{LC} &= (-z, \theta, w, -\varphi, \sigma), \\ s_6^{LC} &= (-z, \pi - \theta, -w, -\varphi, -\sigma), \\ s_7^{LC} &= (-z, \pi - \theta, w, \varphi, \sigma). \end{aligned} \tag{15}$$

Proof. The invariance of equations (14) to the transformations (15) can be immediately verified. □

Imitating the proofs performed for the four-elements groups presented in the previous sections, we are in the position to state:

Proposition 6.2. *Out of the eight symmetries s_i^{LC}, $i = \overline{0,7}$, of the vector field (14), only three are mutually independent.*

Theorem 6.3. *The set $G^{LC} = \{s_i^{LC} | \ i = \overline{0,7}\}$, endowed with the composition law "$\circ$", forms a symmetric Abelian group with an idempotent structure.*

Examining the symmetries in (15) that regard θ, we see that Remark 3.4 is retrieved here, too.

7. Main results

Remark 7.1. The motion equations of Hénon-Heiles'-two-body problem, expressed in configuration-momentum or polar coordinates, or in (collision-blow-up or infinity-up) McGehee-type coordinates, present remarkable symmetries that form four-element Abelian groups endowed with an idempotent structure.

Theorem 7.2. *The groups $G, G^{pol}, G^c, G^\infty$ are isomorphic.*

Proof. Each of these groups is an Abelian group of order 4 with two generators of order 2. According to the Fundamental Theorem of Abelian groups, they are isomorphic to $\mathbb{Z}_{\not 4} \oplus \mathbb{Z}_{\not 4}$. □

Remark 7.3. Theorem 7.2 is not a trivial result. Recall that the phase space corresponding to G^c contains the supplementary boundary manifold M_c, whereas the one corresponding to G^∞ contains the supplementary (boundary) infinity manifold.

Corollary 7.4. *$G, G^{pol}, G^c, G^\infty$ are isomorphic to Klein's group.*

Proof. See the proof of Theorem 7.2. □

Remark 7.5. The group G is not only isomorphic, but diffeomorphic to G^{pol}.

Remark 7.6. Among all these groups, G^{pol} is the closest to the physical description of the motion, due to the use of both natural polar coordinates and physical time.

Theorem 7.7. *The group G^{LC} has seven proper subgroups of order 4 isomorphic to Klein's group.*

Proof. Constructing the 8×8 composition table corresponding to G^{LC}, we observe that there exist four-element subgroups $H_{ijk}^{LC} = \{I^{LC}, s_i^{LC}, s_j^{LC} | \ i = \overline{1,7}\}$ such that $s_i^{LC} = s_j^{LC} \circ s_k^{LC}$, $s_j^{LC} = s_i^{LC} \circ s_k^{LC}$, $s_k^{LC} = s_i^{LC} \circ s_j^{LC}$. These subgroups are H_{124}^{LC}, H_{135}^{LC}, H_{236}^{LC}, H_{167}^{LC}, H_{257}^{LC}, H_{347}^{LC}, H_{456}^{LC}. It is easy to see that they all are Abelian with two generators of order 2, hence isomorphic to Klein's group. □

The symmetries pointed out in this paper are of much help in understanding various characteristics of the global flow of either the general problem or a concrete problem at hand. Indeed, for each solution proven to exist, they show the existence of several other solutions.

Moreover, these symmetries are very useful to find symmetric periodic orbits – especially by means of the continuation method – in perturbed two-body problems

depending on a small parameter ε, such that, as usual, for $\varepsilon = 0$ we recover the unperturbed problem. This especially aids to the study of the restricted three-body problem in such a model. In fact, symmetries play an essential role in searching for periodic orbits in most problems of celestial mechanics (Diacu 2003).

References

[1] McGehee, R.: 1973, *J. Diff. Eq.*, **14**, 70.

[2] McGehee, R.: 1974, *Invent. Math.*, **27**, 191.

[3] Mioc, V., Barbosu, M.: 2003, *Serb. Astron. J.* (submitted).

[4] Diacu, F.: 2003, "Lecture held at the Annual Scientific Session of the Astronomical Institute of the Romanian Academy," 15–16 May 2003, Bucharest.

[5] Hénon, M., Heiles, C.: 1964, *Astron. J.*, **69**, 73.

[6] Levi-Civita, T.: 1904, *Ann. Mat. Pura Appl.*, **9**, 1.

Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 169–173

INTERACTION OF GRAVITATIONAL, ELECTROSTATIC AND ELECTROMAGNETIC FIELDS – ITS IMPACT ON PHYSICAL PHENOMENA AND MODES OF EXPERIMENTAL VERIFICATION

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Received October 9, 2003

This contribution is aimed at 1) rationalizing the reasons of different and unpredictable efficiency reached within experimental investigation of inverse Compton scattering and cold fusion, 2) theoretical deriving conditions required to obtain the maximum efficiency in the mentioned phenomena, the Casimir effect and oscillation circuit, 3) proposing simple experiments enabling to verify the theoretically derived conditions for the above phenomena. To reach the mentioned goals, the model of Expansive Nondecelerative Universe is applied. The background of the rationalization lies in a hypothesis on the possible interferention of gravitational, electrostatic and electromagnetic fields and on its impact on the mentioned phenomena. Due to the fact that the discussed phenomena occur in the presence of the Earth gravitational field, the energy density of this field is taken into consideration and introduced into particular calculations.

1. Introduction

The model of Expansive Nondecelerative Universe (ENU) [1-3] has proven its usefulness in prediction and rationalization of several physical phenomena both of micro-world and macro-world nature. The results obtained can be exemplified by prediction of lattice vibration peaks in low-temperature far-infrared spectra [4], derivation of the proton to electron masses ratio [5], prediction of black holes upper and lower mass limits including their non-evaporability [6], rationalization of the de Aquino's and Podkletnov's phenomena including the mechanism of solar corona heating [2, 7], entropy-related phenomena including time evolution of the Universe specific entropy [3], neutron star pulsars properties [8], etc. Most of the compliances between the experimentally observed parameters and those predicted or independently derived by the ENU stem from relations of energy densities, energy outputs or wavelengths related to the evaluated phenomena and from hypothesis on a possible intereference of electromagnetic, electrostatic and gravitational fields. It is supposed that such an interference operates due to (formally) very similar behaviour of the fields, e.g. their intensity decreases with the square of distance, they are of wave nature, Yukawa potential is applicable to them, etc. A possibility of this interference is strongly supported by the de Aquino's and Podkletnov's experiments [2, 7].

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This contribution is aimed at 1) rationalizing the reasons of different efficiency reached within experiments devoted to inverse Compton scattering and cold fusion, 2) ENU-based theoretical deriving conditions required to obtain the maximum efficiency of the mentioned phenomena, the Casimir effect and oscillation circuit, 3) proposing simple experiments enabling to verify the theoretically derived conditions for the above phenomena.

2. Inverse Compton Scattering

Experimental study of several physical, chemical and biological phenomena frequently is conditioned by the availability of high intensity short pulses of radiation from X-ray, UV, visible or IR regions. While generation of nanosecond, picosecond, or femtosecond pulses of UV, visible or IR radiations has been coped with for many decades, and attosecond technique has recently been emerged [9], formation of short pulses of energy higher photons (γ or X-ray) is still in infancy. An exploitation of picosecond X-ray pulses in the investigation of molecular structure of compounds in electronically excited states [10] has been documented very recently. One of the methods producing ultrashort flashes of X-rays is inverse Compton scattering. This phenomenon is thus both of theoretical importance providing valuable information on matter-radiation interactions, and practical meaning offering a source of ul-

trashort γ or X-rays flashes production.

Inverse Compton scattering is an energy exchange process occurring at interaction of high-energy (relativistic) electrons with low-energy photons producing high-energy (γ or X-ray) photons and low-energy electrons. Energy spectrum of the photons formed at nonlinear inverse Compton scattering of electrons moving in the laser field during the interaction time T is given by Lienard-Wiechert potential [11, 12]

$$\frac{d^2 i}{d\omega\, d\theta} = \frac{e^2\omega^2}{4\pi^2 c}\times$$

$$\times \left| \int_{-T/2}^{T/2} dt\, [\boldsymbol{n}\, x\, \boldsymbol{n} \times \boldsymbol{\beta}] \exp\left[i\,\omega \left(t - \frac{\boldsymbol{n}.\,\boldsymbol{r}}{c} \right) \right] \right|^2 , \quad (1)$$

where i and ω are the intensity and frequency of scattered photons, respectively, θ is the solid angle of radiation, $\boldsymbol{r}$ is the electron position in the laser field, $\boldsymbol{n}$ is the unit vector pointing in the direction of observation, $\boldsymbol{\beta} = \boldsymbol{v}/c$ where $\boldsymbol{v}$ is the velocity vector of electron.

In the Expansive Nondecelerative Universe model (ENU), introducing Vaidya metric [13, 14] and applying Tolman approach it is possible to localize and quantify the gravitational field energy density ε_g exerted by a body with the mass m at the distance r

$$|\varepsilon_g| = \frac{R\, c^4}{8\pi\, G} = \frac{3\, m\, c^2}{4\pi\, a\, r^2}. \quad (2)$$

$R$is the scalar curvature (contrary to a more frequently used Schwarzschild metric, in Vaidya metric $R \neq 0$), a is the Universe radius calculated in ENU [3]

$$a \cong 1.299\, x\, 10^{26} \text{ m}. \quad (3)$$

The energy density ε_g can be related to the frequency ν_g

$$\nu_g = \left(\frac{\varepsilon_g\, c^3}{\hbar} \right)^{1/4} = \left(\frac{3\, m\, c^5}{4\,\pi\, a\, r^2 \hbar} \right)^{1/4}. \quad (4)$$

Then, based on (4), for any elementary particle with the mass m and the Compton wavelength $\lambda_C = r$ it holds

$$\nu_g = \left(\frac{3\, m^3\, c^7}{4\,\pi\ a\, \hbar^3} \right)^{1/4}. \quad (5)$$

Introducing the Planck mass m_{Pc} (the maximum particle mass, $m_{Pc} = 2.176716 \times 10^{-8}$ kg) into relation (5), the maximum frequency follows as

$$\nu_{g(\max)} = 7.71 \times 10^{27} \text{ Hz}. \quad (6)$$

Putting the Newton and Coulomb law equal, is follows that

$$m_{\max} = m_{Pc}\, \alpha^{1/2}, \quad (7)$$

where the fine structure constant $\alpha = 7.29735 \times 10^{-3}$. This is the reason of a higher frequency for charged particles. For such particles, relation (5) must be normalised through the following equation

$$\nu_g = \left(\frac{3\, m^3\, c^7}{4\,\pi\ \alpha^{3/2} a\, \hbar^3} \right)^{1/4}. \quad (8)$$

Now, inverse Compton scattering occurring within interaction of relativistic electrons and low energy photons having the frequency ν_e and mass m, and obeying relation (9)

$$\nu_e = \nu_g \quad (9)$$

will be treated. The energy of these electrons must higher than 50 MeV since only such electrons can exert gravitational influence to their surroundings [15]. In case the electron energy is 60 MeV, relation (8) leads to the frequency of colliding photons

$$\nu_g = 2.86 \times 10^{13} \text{ Hz}, \quad (10)$$

which corresponds to the wavelength

$$\lambda_e = 10.6\ \mu\text{m}. \quad (11)$$

This is the value exactly matching the measurements by Kashiwagi [16, 17], Pogorelsky [18] and Kamiya [19]. At the experiments X-rays of the energy

$$E_{RTG} \cong 6 \text{ keV}, \quad (12)$$

were produced. The energy gain EG, calculated as a ratio of the energies of produced (scattered) and original (colliding) photons reached

$$EG \cong 5 \times 10^4. \quad (13)$$

It is obvious that also different frequences of colliding photons can be used, in such cases, based on (8) and (9), the energy gain would be lower.

For the electrons with the energy 8 GeV, relation (8) provides the frequency

$$\nu_g = 9.8 \times 10^{14} \text{Hz}. \quad (14)$$

It is very close to the value used by Fujiwara [20]

$$\nu_g = 8.3 \times 10^{14} \text{ Hz}. \quad (15)$$

In this case, γ-quanta with the energy

$$E_\gamma \cong 2.4 \text{ GeV}, \quad (16)$$

were produced and the energy gain of photons has reached the maximum up-to-now obtained value

$$EG \cong 7 \times 10^8. \quad (17)$$

3. The Earth gravitational field and inverse Compton scattering

All physical, chemical and biological phenomena and processes occurring on the Earth are subject to the Earth gravitational field and can be influenced by this field. In several cases this influence is believed to be negligible. Provided that, in general, there is a possibility of any observable interaction (interferention) of the gravitational field with electrostatic or electromagnetic fields, the parameters of the Earth gravitational field must be taken into account when assessing the processes in which the electrostatic and electrodynamic operate. We will demonstrate such a would-be interaction in evaluating the maximum efficiency of inverse Compton scattering performed on the Earth.

When substituting the Earth mass and radius into equation (4), the corresponding frequency of the Earth gravitational field is

$$\nu_g = \left(\frac{3\, m_{Earth}\, c^5}{4\, \pi\, a\, r_{Earth}^2 \hbar} \right)^{1/4} = 1.55 \times 10^{15}\ \text{Hz}. \qquad (18)$$

To this frequency, the electron mass calculated using (8)

$$m_e = 12.6\text{GeV} \qquad (19)$$

is associated. It follows from the above values that at normal conditions at the Earth surface, the maximum energy gain of photons at the colliding frequency (18) and electron mass (19) approaches to

$$EG \cong 10^9, \qquad (20)$$

i.e. at the scattering, the photons (γ-rays) with the energy

$$E_\gamma \cong 6.3\ \text{GeV} \qquad (21)$$

will be produced. The energy gain (20) is the maximum obtainable at the Earth conditions. At this situation, interference of electromagnetic field with both the gravitational fields of the Earth and electrons should happen. The higher deviation from the values given by (18) and (19), the lower energy gain of the colliding photons. This ENU-based prediction is verifiable by the technique available at present.

4. Specific Oscillation Circuit

The electric energy density ε_e between condenser plates is given by relation

$$\varepsilon_e = \frac{C\, V^2}{2\, S_1\, d}, \qquad (22)$$

where C and V are the inter-plate capacity and voltage, respectively, S_1 is the area of the plates and d is inter-plate distance. Based on (2), the gravitational energy density at the Earth surface is calculated as

$$\varepsilon_{g(Earth)} = 24.29\ \text{J m}^{-3}. \qquad (23)$$

If the energy densities given by (22) and (23) become equal, knowing the values of S_1, C and d, the required voltage V can be calculated.

At the solenoid axis, the electromagnetic energy density ε_{em} is given as

$$\varepsilon_{em} = \frac{L\, I^2}{2\, S_2\, \ell}, \qquad (24)$$

where L is the solenoid inductance, S_2 is the cross-section area, ℓ is the solenoid length. In case of equal densities expressed by (23) and (24), stemming from known values of L, S_2 and ℓ the current I is obtained.

Let us build-up an oscillation circuit with the angular frequency ω

$$\omega = \frac{V\, I}{2\, \varepsilon_{g(Earth)}\, (S_1\, S_2\, \ell\, d)^{1/2}} \qquad (25)$$

in which the voltage and current are those calculated above and the gravitational energy density will be that of the Earth (23). We suppose an interference of the electromagnetic field of the oscillation circuit with the gravitational field of the Earth. As a consequence, properties of the oscillation circuit might be modified.

5. The Casimir effect

The phenomenon called now the Casimir effect [21] was named by H. Casimir who predicted [22] in 1948 the existence of a small attractive force which acts between two parallel uncharged conducting plates due to quantum vacuum fluctuations of the electromagnetic field. The Casimir energy density ε_C can be expressed as

$$\varepsilon_C = \frac{\pi^2\, \hbar\, c}{720\, d^4}, \qquad (26)$$

where d is the distance between the plates. Comparing (23) and (26) it follows that if there is any interaction of the Earth gravitational field energy and the Casimir energy, it should be the most effective when both the energy densities are equal, i.e. at

$$d = 6.45 \times 10^{-8}\ \text{m}. \qquad (27)$$

Up to now such a distance has not been experimentally obtained, improved techniques to control the inter-plate distance seem to be, however, promising in reaching this distance.

6. Cold Fusion

Cold fusion process, originally announced by Fleischmann and Pons [23] and subsequently patented [24] is still a matter of scientific controversy. Numerous performed independent replications of cold fusion experiments have brought both the confirmations of the original declaration that more energy is produced by

than input to the process, and information of failing to harvest any "extra" energy. Our tentative explanation of the mentioned significantly different results lies in a hypothesis that the extra energy can be released only when certain parameters match. In analogy to the previous sections of this paper we propose that cold fusion can be effective only when there is a specific interaction of the input gravitational and electric fields associated with the performed electrolysis. In the optimum case the electric energy input P_i is just equal to the electrolytic cell gravitational output P_g [2] which is given, based on (2) as

$$P_i = |P_g| = \frac{d}{dt} \int \frac{R c^4}{8 \pi G} dV = 0.2095\, m. \qquad (28)$$

In (28) m is the mass of electrolyzed solution in kg, P_g is expressed in J s^{-1}.

In the patent [24], the energy input was about 0.06 W (leading to the output 5 W) and as an electrolyte, about 320 g of 2 mol dm^{-3} Li_2SO_4 was used. In a typical experiment [25, 26] the input was 767.7 W and the output reached 1289.1 W. 600 ml of 0.2 mol dm^{-3} K_2CO_3 was electrolysed at Pd-cathode, the output : input ratio varied between 1.2 and 1.7. The Patterson's values [24] are close to those required by equation (28) and this is why its output : input ratio was so high ($\cong$ 83). It is possible that in cases failing to reproduce extra energy production, operational parameters differ from that required by (28). It might be a stimulating idea to perform experiments obeying conditions stipulated by (28).

7. Conclusion

In an interview, Rudolph A. Marcus, 1992 Nobel Laureate in Chemistry, expressing his meaning on the interaction between the theory and the experiment stated [27]: "If you produce a theory that you just rationalize the experiment and can't make predictions, you can't really test it". We are convinced that these words clearly define the essence of theoretical scientific work. Taking this aspect into account, following the creation of a background of the ENU model, major part of our efford has been focused both to rationalize known facts by independent ways, to predict some phenomena, and to offer new experiments to verify the theoretical predictions. To such an goal should serve also the present contribution.

Acknowledgements

This work was supported by Science and Technology Assistance Agency under the contract No. APVT-20-010902.

References

[1] V. Skalský, M. Súkeník, *Astrophys. Space Sci.*, 178 (1991) 169.

[2] M. Súkeník, J. Šima, *Spacetime & Substance*, 2 (2001) 125.

[3] J. Šima, M. Súkeník, *Entropy*, 4 (2002) 152.

[4] J. Šima, M. Súkeník, http://xxx.lan.gov/abs/gr-qc/9903090.

[5] M. Súkeník, J. Šima, *Spacetime & Substance*, 3 (2002) 31.

[6] J. Šima, M. Súkeník, *Spacetime & Substance*, 2 (2001) 79.

[7] M. Súkeník, J. Šima, *Spacetime & Substance*, 3 (2002) 118.

[8] M. Súkeník, J. Šima, *Spacetime & Substance*, 3 (2001) 35.

[9] F. Krausz, *Phys. World*, 14 (2001) 41.

[10] P. Coppens, I. Novozhilova, A. Kovalevsky, *Chem. Rev.*, 102 (2002) 851.

[11] F.V. Hartemann, "High-Field Electrodynamics," CRC Press, Boca Raton, 2001.

[12] A. Fukasawa, H. Iijima, M. Uesaka, J. Urakawa, T. Higo, M. Akemoto, H. Hayano, Proc. Second Asian Particle Accelerator Conf., Beijing, China, (2001) 843.

[13] P.C. Vaidya, *Proc. Indian Acad. Sci.*, A33 (1951) 264.

[14] K.S. Virbhadra, *Pramana – J. Phys.*, 38 (1992) 31.

[15] M. Súkeník, J. Šima, *Spacetime & Substance*, 3 (2003) in press.

[16] S. Kashiwagi, Y. Hama, H. Ishikawa, H. Kawai, R. Kuroda, K. Maeda, H. Nagasawa, T. Oshima, M. Washio, A. Yada, H. Hayano, J. Urakawa, Proc. EPAC, Paris, France (2002) 694.

[17] S. Kashiwagi, M. Washio, T. Kobuki, R. Kuroda, I.V. Pogorelsky, I. Ben-Zvi, K. Kusche, J. Skaritka, V. Yakimenko, T. Hirose, T. Muto, K. Dobashi, J. Urakawa, T. Omori, T. Oguki, A. Tsunemi, D. Cline, Y. Liu, P. He, Z. Segalov, *Nucl. Instr. Methods Phys. Res.*, A455, 36 (2000) 669342.

[18] I.V. Pogorelsky, I. Ben-Zvi, T. Hirose, S. Kashiwagi, V. Yakimenko, K. Kusche, P. Siddons, J. Skaritka, T. Kumita, A. Tsunemi, T. Omori, J. Urakawa, M. Washio, K. Yokoya, T. Oguki, Y. Liu, P. He, D. Cline, *Phys. Rev. ST– AB*, 3 (2000) 090702.

[19] Y. Kamiya, T. Kumita, I. Ben-Zvi, K. Kusche, I. Pogorelsky, P. Siddons, V. Yakimenko, T. Omori, J. Urakawa, K. Yokoya, T. Hirose, S. Kashiwagi, M. Washio, D. Cline, F. Zhou, 26^{th} Advanced ICFA Beam Dynamics Workshop on Nanometre-Size Colliding Beams, Lausanne, Switzerland (2002).

[20] M. Fujiwara, T. Hotta, T. Kinashi, K. Takanashi, T. Nakano, Y. Ohashi, S. Date, H. Ohkuma, N. Kumagai, *Acta Phys. Pol., B29*, (1998) 141.

[21] M. Bordag, U. Mohideen, V.M. Mostepanenko, *Physics Reports*, 353 (2001) 1.

[22] H.B.G. Casimir, *Proc. Kon. Nederl. Akad. Wetensch.*, B51 (1948) 793.

[23] M. Fleischmann, S. Pons, *J. Electroanal. Chem.*, 261 (1989) 301.

[24] J.A. Patterson, US Patent 5,318,675 (July 6, 1994).

[25] T. Mizuno, T. Ohmori, Infinite Energy 4 (1998) 14.

[26] J.-L. Naudin, http://www.jlnlabs.org.

[27] R.A. Marcus, *Spectrum*, 16 (2003) 4.

Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 174–181

ON NOTIONS OF RELATIVISTIC DYNAMICS

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Received July 8, 2003

The paper is devoted to the detailed criticism of dynamical concepts of the special relativity theory (SRT), of some relativistic solutions and their experimental interpretation.

1. Introduction

During the SRT life time the papers have repeatedly appeared, which contained some criticism of SRT [1-5]. However, the criticism of SRT had only partial character, as a rule, and affected only separate aspects of this theory. The current of the criticism and its quality was considerably increased in the end of the last century only [6-10]. Since there exists the professional fundamental apologetics of SRT [11-21], the main purpose of the author was to present a successive, systematic criticism of RT just resting upon a fine apologetics of this theory [22-26]. The critical works contain, virtually, no papers on the relativistic dynamics. This fact was one of the main incentives for writing this paper.

Section 2 contains the criticism of dynamical concepts of SRT and of some relativistic experiments. Section 3 contains the conclusions.

2. Criticism of Dynamical Concepts of SRT

It would seemed that only in the relativistic kinematics there are no direct experimental comparisons of physical quantities (only doubtful interpretations) for two systems moving relative to each other; but in the relativistic dynamics everything is in order (according to relativists' logic – the accelerators are operating, in fact!). Let us try to clear up the dynamical concepts, even because the relativistic dynamics, under modern interpretation of SRT apologists, rests upon a completely untrue relativistic kinematics.

We begin with general notes. A boundless spreading of the idea of relativity of all quantities in SRT is completely groundless. Really, let the two bodies be at distance $\mathbf{r}$ apart of each other while having relative velocity $\mathbf{v}$. Then the result of interaction of these bodies at instant $t + dt$ will not be determined by mentioned characteristics, but will depend on the prehistory of motion. Since the effect spreads at finite velocity, the first body at instant t_1 will be influenced not by the real second body (at instant t_1) with its coordinates and velocity, but by some its "image" from a preceding point of the trajectory, from which the effect had time to come before instant t_1. Thus, any physical quantity (the force, for instance) can not depend on the relative velocity at the same instant only. The only exception is the frontal collision, at which $\mathbf{r} = 0$. Therefore, it is necessary either to apply more complicated equations instead of the local differential equations (i.e. to take into account the prehistory), or to refuse from the idea of relativity of all quantities. Even the notion of the "relative velocity at the given time instant" itself becomes indefinite, because any real effect will be determined by characteristics at preceding instants. And, you see, SRT does not "know" the absolute velocity organically (it "knows"only the relative one). This fact has already resulted in the discomfiture. For example, Einstein has actually believed the aberration to depend on the relative velocity of the Earth and a star. However, the experiment shows the aberration to be dependent on the Earth velocity only, but the velocity of a star has no effect at all. In spite of vast scattering of velocities of stars, the aberration on the Earth is found to be the same for all stars. Where has the relative velocity gone in such a case? Actually, even this fact disproves the original concept of SRT. A similar disproof of SRT is obtained in the problem on a coil in the magnetic field: the motion of a coil induces the current in it immediately, whereas the motion of a magnet (according to the finiteness of the rate of interactions) – only after some time. There is no symmetry of the problem, and the dependence on the relative velocity only is obviously insufficient.

Now we proceed to more specific dynamical concepts. We begin with the concept of "mass." In order to introduce correctly the new physical concept of the "mass of a moving body" into SRT, it is necessary, first, to determine the procedure of measuring similar

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moving masses independently of any theory. (A similar procedure in GRT relates to the "mass of a body in the gravitational field": the distinction of the gravitation mass from inert one, as contrary to its own postulate). And this procedure should be namely the measurement, rather than re-calculation, for example, via the postulated formula for energy or momentum again. Otherwise the theory will try to "retain itself by the hair." A similar measurement procedure does not exist for SRT.

The physical concept of "mass" has no direct relation to all those formulas (it is mathematics), which can include letter "m." For the basis concept of mass there exists the only clear – standard definition. It determines the mass just at the state of rest (for example, the conditions also exist for the standard of length – the temperature ones). And there is no need to "invent a bicycle." In the motion the mass is simply not defined, though letter m can enter quite diverse formulas containing $\mathbf{v}, \mathbf{a}$, etc. These are different things! Therefore, the definition of an elementary concept of mass in terms of more complicatedly defined concepts of energy and momentum (depending on the theory, interpretation, state of a system, etc.) is a physical nonsense (though, possibly, it is correct mathematically). In such a manner one can "reach" an absurd and define a simple notion of velocity as $\mathbf{v} = \mathbf{p}c^2/E$. Note that any experiment, including measurement one, should be extremely clear defined with respect to all conditions of its performing. And, generally speaking, the "explanations" and "definitions" of theoretical physics (for example, in SRT) often represent by themselves a drop-out from physical understanding and a science-like masking of the essence of quantities behind (often correct) mathematical transformations.

Even such a simple notion as "the center of masses of a system" becomes ambiguous in SRT in considering the mutual motion of system's components. So, in [16] the "paradox of a center of masses" is considered: in the reference frame of a rocket two identical cannon balls are fired off simultaneously inside a tube, and the ends of a tube are tightly closed immediately. In the classical physics no contradictions arise in this case: the center of masses in any frame of reference will always coincide with the center of a tube. It can be determined by various methods, namely: by weighing and direct calculation (the mass and distances are invariant in the classics), as a center of zero momentum, as a center of a baryon number (the number of nucleons in nuclei), as a center of gravitational attraction. The notion of the center of baryon number was declared "non-productive" in [16], since the world line of this center occurs to be irrelevant to the SRT laws (that is, it simply contradicts them!). The gravitation is organically not included into SRT, so that one should transfer to GRT, but the book [16] declares the coincidence of the center of gravitational attraction with the middle of a tube in the laboratory coordinate system (but in this case "the center of zero momentum" is studied). However, immediately after the first collision with a plug (non-simultaneous in the laboratory system) it becomes necessary to refuse from the universality of SRT and to recall about a specific compensation mechanism (for "saving" SRT) – on the acoustic waves in a tube and on the energy (mass) transfer by them. These waves, coming from tube's ends, then suppress each other. But in such a case one should have to postulate various velocities of acoustic waves in various systems for two opposite directions. And if we will change the material of a tube and the geometrical characteristics of the experiment? And if the tube is absent at all and only the plugs of very great mass are present, and the sensitivity of local gravitation measurements will allow for determining the motion of cannon balls? And what should be done with the compensation mechanism in the cases listed above?

If in the given problem we shall determine the mass from the momentum transfer on plugs or on barriers parallel to them (the "longitudinal" mass), then we obtain some single world line of the center of masses. If, however, the mass will be determined from the pressure on the tube bottom (from the gravitation; from the electrical force for charged cannon balls or from the magnetic force for cannon balls-magnets, etc.), then for this ("transversal") mass the other world lines will exist. Generally speaking, in SRT all these world lines will be different. Some of them have to be postulated as senseless (non-productive for SRT), in some cases it would be necessary to transfer to particular mechanisms "explaining" the contradiction, and in other cases the change of objective characteristics should be postulated. For example, let the plug to be retained on a massive tube with the force slightly greater, than that required for a plug to be torn-off by a cannon ball (with "relativistic" mass) in rocket's frame of reference. Then in the laboratory frame of reference one of cannon balls (with a greater "relativistic" mass in this case) will beat the plug out. So, is the observer behind this plug alive or dead? Or, again, for "saving" SRT it is necessary to postulate that the plug-retaining limit in SRT is not an objective characteristic (but depends on the frame of reference)? And if at tube's ends there will be the "traps" at the bottom, in order that in rocket's frame of reference the ("transversal relativistic") mass be slightly insufficient for a cannon ball to be fallen down there. Then, again, in the laboratory frame of reference one of cannon balls (with a greater "relativistic" mass) will fall down. So, shall we postulate again the change of the threshold strength for "saving" SRT? Note that it would be necessary to postulate different threshold characteristics: both the longitudinal and transversal (generally, tensor) ones. Whether the SRT price is not too great – the price of postulating a loss of the majority of objective characteristics? Whether the number of problems, questions and contradictions is not too great in SRT "at the empty place" – where

in the classical physics everything would be elementary simple? And, you see, SRT can not refuse from the concept of the center of masses, since the Einsteinian derivation of the $E = m_0c^2$ equivalence for the "rest mass" is based on this particular concept.

SRT gives nothing useful in the kinematics [22-24,26] and for dynamical concepts as well. It occurs that all this huge number of additional complications arises only because of the fact, that the electromagnetic Lorentz force too "complicatedly" depends on the velocity (more correctly, on the acceleration)?! Generally speaking, the real forces should be determined from the experiment. The following forces are known:

$$\mathbf{F} = constant, \quad \mathbf{F} = \mathbf{F}(t), \quad \mathbf{F} = \mathbf{F}(\mathbf{r}),$$

$$\mathbf{F} = \mathbf{F}(t, \mathbf{r}, \mathbf{v}), \quad \mathbf{F} = \mathbf{F}(d^3\mathbf{r}/dt^3)$$

and so on in quite various combinations. From the generalized expression

$$\mathbf{F} = \mathbf{F}(t, \mathbf{r}, \dot{\mathbf{r}}, \ldots, d^3\mathbf{r}/dt^3, \ldots)$$

it is seen that any derivative, including the second one, is not distinguished by anything, and only the experiment can determine the varieties of forces realized in the nature (recall, for example, the formula offered by Weber). For example, the relativistic equation of motion with the Lorentz force $\mathbf{F}(t, \mathbf{r}, \dot{\mathbf{r}})$ can be written as the classical second Newton's law with the force $\mathbf{F}(t, \mathbf{r}, \dot{\mathbf{r}}, \ddot{\mathbf{r}})$. One should not also exaggerate the possibilities of the methods for obtaining expressions from the Lagrangian, since this function itself is determined to an accuracy of some expansion terms and can not determinate the principles.

Let us make now a comment concerning the units of measurement. The expression for the momentum and energy in terms of a mass can not give anything useful, since these quantities are not interchangeable, the number of joint operations with them (as well as combinations) is limited and, all the same, it is necessary to monitor them as various physical quantities. Whether is it worth to introduce confusion into well-agreed units of dimensions?

Whether the SRT approach to the relativistic dynamics is a unique one? Not at all! In the classical physics the separation of energy into kinetic and potential ones can be rather conventional. For example, in the statistical physics at description of motion in non-inertial rotating systems the potential energy includes, in fact, the mean kinetic (!) energy of motion of a system: from $v_\varphi = \Omega\rho$ is generated $E_{pot} = m\Omega^2\rho^2/2$. There exists another educative example from the hydrodynamics, where the apparent ("effective") mass concept is introduced for describing the motion of a body through a medium. The true mass did not obviously change in this case. In exactly the same manner, in the relativistic mechanics a new "velocity" addition to the acceleration can be associated with the potential energy of a body. In this case the kinetic energy of a body can be retained invariable, and the classical Newtonian equations can be considered, but with other, "effective" force and constant mass m_0.

Completely unclear methodically looks in SRT the transformation of forces at transition from one frame of reference to another. Let us consider, for example, two identical charges e being at distance $\mathbf{r}$ apart of each other. In the frame of reference bound with resting charges there exists the electric force $F = e^2/r^2$ acting between the charges. Look now at the same charges from the system moving at velocity $\mathbf{v}$ perpendicular to the line connecting the charges (in this system the charges are flying parallel to each other). According to SRT [12,27], now between the charges acts the force

$$F' = Ge^2/r^2, \qquad \text{where} \quad G = \sqrt{1 - v^2/c^2}.$$

To what physical quantity should be related the transformation factor G? The charge is invariant in SRT. Distance r, which is perpendicular to the motion, does not change as well. So, do the forces really lose their physical causes in SRT?

Completely groundless is Einstein's statement, that uncharged bodies must behave under an effect of forces in exactly the same manner as charged ones: all forces must be transformed identically. Still Poincare wrote that we can not arbitrarily "disconnect" some force from one body and arbitrarily "connect" it to the other body. If some force (for example, electrical) acts on some (charged) bodies and does not act at all on the other (uncharged) bodies, then, all the more, is not obvious that velocity dependencies should be identical in transformations of all forces. This is one more hypothesis not confirmed by anything even within the SRT framework. Probably, the transformation of forces has relation to only one particular case – the Lorentz force. And even in this case there are some nuances here. For example, at transition to a moving system the magnetic force magnitude can become zero. These facts represent the manifestations of conventional character of separating a single force into electrical and magnetic forces, don't they? In such a case, why the attention should be concentrated on the transformation of conventionally separated electrical and magnetic fields (and forces)?

Contrary to the SRT assertions on the importance and necessity of introducing the 4-dimensional vectors, even for three interacting particles the expressions

$$E = \sum_i m^{(i)}c^2\gamma^{(i)}, \quad \mathbf{P} = \sum_i m^{(i)}\mathbf{v}^{(i)}\gamma^{(i)},$$

where

$$\gamma^{(i)} = \frac{1}{\sqrt{1 - v_i^2/c^2}}$$

do not constitute the 4-dimensional vectors and are not conserved. The introduction of the potential energy

of interaction of particles also causes some difficulties. Is SRT a theory of two bodies, really? Where is the declared generality (universality) of the theory? Similar difficulties arise in constructing the Lagrangian and Hamiltonian functions for systems of interacting particles.

A limiting transition to the classical energy is contradictory too. Above we have considered the condition of such a transition: $c \to \infty$. But in such a case not only the energy of rest, but any other energy will be $E = \infty$. Not consistent is also the expression for the relativistic momentum in the form of [21]: $\mathbf{P} = m\frac{d\mathbf{r}}{d\tau}$, since $d\mathbf{r}$ relates to the motionless frame of reference, and $d\tau$ (the intrinsic time) relates to the moving system (i.e. to a body).

Now we shall analyze the "principal" question on the invariance of the Maxwell equations, which is widely advertised in SRT. The invariance of the Maxwell equations with respect to the Lorentz transformations implies nothing for the other phenomena. First, the Maxwell equations are the equations for fields in the empty space. In such a space we can cut off a half of a segment and increase it as much as twice – then we obtain the same segment. Therefore, in the empty mathematical space one can make use of any frames of references, of self-consistent geometries and conversion factors. All these operations can be determined by the convenience of mathematical description only. However, we can not simply cut-through a living organism and increase it twice under a microscope – the organism will be dead. The presence of real physical bodies and fields in the space specifies natural reference points ("bench-marks"), characteristic scales and interrelations between the objects. All this determines the distinctions of a real physical space from the empty mathematical space. Second, the property of some interactions to propagate in vacuum at the speed of light does not determine the rate of interactions' propagation in a medium. In spite of a drastic role of electromagnetic interactions, the disturbances in media propagate at the speed of sound. From one vacuum-related constant c it is impossible to determine (for our "electromagnetic" world) the speeds of sound and light in gases, liquids and solid bodies. It is not clear, how the anisotropy of real solid bodies could arise in the isotropic space. All these and many other properties escape the limits of applicability of the Maxwell equations in the emptiness. Therefore, the fitting of the properties of the entire world under the invariance of these equations is too excessive claim of SRT. Third, the partition of a single (in its effect) field into electrical and magnetic parts is rather conventional and, to a considerable extent, arbitrary. Hence, the invariance of these, artificially singled out parts can not have crucial significance. The presence of ρ, ϵ, μ coefficients (which depend on coordinates, time, properties of light, etc.) for the Maxwell equations in a medium makes these equations non-invariant relative to the Lorentz transformations (or is it necessary to cancel the objectivity of characteristics of media again?).

The relativistic bond of the mass and energy actually reflects no principal thing. Indeed, the classical expression for kinetic energy $E = mv^2/2$ and the relativistic expression $E = mc^2((1 - v^2/c^2)^{-1/2} - 1)$ do not differ in any (qualitatively) significant thing. Both these quantities are calculated quantities. The attempt to measure these quantities (that is, the calibration of an instrument) depends on interpretation of the theory, since these quantities can not be determined from the comparison with a measurement standard. Since the relativistic expression of energy $E = mc^2/\sqrt{1 - v^2/c^2}$ includes, except the mass, the other quantities, then for any possible interrelations the mass and energy will remain different (nonequivalent, independent) quantities. Even for the so-called "energy of rest" $E = mc^2$ the question can not be about mutual transformations of mass and energy. The fact is, that at annihilation (the only "candidate" for a similar process) the photons are generated, for which the "mass of motion" is postulated in SRT according to the same formula. Therefore, in this case the question is simply about mutual transformations of particles too. To say nothing of the fact, that the "energy of rest" is only the hypothesis of SRT, because this theory leads again to the same indeterminate constant, as in the classical physics.

Not so unambiguous, as the relativists believe, are SRT confirmations by the nuclear physics and elementary particle physics. Note that one equation (equality) can check no more than one dependence between physical quantities (remember Poincare). Here, all physical quantities appeared in this equation should be defined a priory independently, otherwise it will be not a law, but a postulative definition of some unmeasured quantity. Whether the relativistic conservation laws are confirmed? The properties of a new particle are often simply postulated, and in formation or participation of neutral particles they are always postulated. May be it is that particular reason, why so many particles "arose" (to cover a dress of the "bare king")? Consider now in detail the response from the book [16] analyzed with the purpose of demonstrating the SRT "possibilities":

$$H^2(\text{rapid}) + H^2(\text{resting}) \to H^1 + H^3.$$

Even for such a "demonstration" response it occurs that:

1) it is impossible to measure kinetic energies of all participating particles; therefore, the energy conservation law was not verified;

2) in the full energy-momentum balance participate several SRT equations, which have not be verified yet (as a result, the quantities to be verified become simply postulated);

3) in the momenta balance expression the momenta have to be artificially separated in directions, and there

is no warranty that separated particles belong to the same act of interaction (and that they are still not different in the place and time of formation);
4) there are also no tolerances for particles' dispersion angles, which makes doubtful the relative accuracy of $2 \cdot 10^{-6}$ indicated in the book (so, even the deuteron energy was measured to the relative accuracy of 10^{-3} only!);
5) the process of any collision itself, for large particles' dispersion angles especially, represents the accelerated motion of charged particles. Therefore, some radiation should always be observed. However, except the case of direct recording gamma-quanta, the accounting of the energy and momentum of arising field is not encountered anywhere. Thus, the balance in the conservation laws is not verified. Simply, such a value is assigned (postulated) to the quantities not measured independently, that no contradictions with SRT would arise. And SRT tries to prolong this continuous chain of postulations up to infinity.

Let us consider now some particular problems. Methodically paradoxical is the description of motion of charged e particle of mass m_0 in the constant uniform electric field $E_x = E$ (see [19]). Really, in the classical physics the trajectory for $v_y = v_0$ is parabola $x = eEy^2/(2m_0v_0^2)$, and in SRT it is the chain line

$$x = \frac{m_0c^2}{eE}\left(\cosh\left[\frac{eEy}{m_0v_0c}\right] - 1\right).$$

But for large y values the relativistic trajectory is close to an exponential curve, i.e. it is steeper, than parabola. But what in this case we should do with the idea on increasing the inertia (mass) of a body with the velocity? Even if we suppose that, despite a slightly greater steepness, the particle is slower moving over the trajectory, then due to which forces it has been slowed down over axis y? You see, force $F_y = 0$, and it will not appear in SRT as well: $F'_y = 0$. And the initial velocity value $v_y = v_0$ can be non-relativistic (and will remain the same).

Strange is the energy balance for a relativistic missile [16]:

$$m\cosh\theta + M_2\cosh(d\theta) = M_1.$$

At high ejection rate ($\theta = \tanh(v/c)$) for finite values of initial M_1 and final M_2 masses the following condition (for SRT consistency) should be fulfilled: the mass of a separate ejection $m \to 0$. However, this quantity is determined by technological design of the rocket only: there are no principal limitations.

One of derivations of Einstein's relation $E = mc^2$ is insufficiently substantiated. The process of absorption of two symmetrical light pulses by a body in this derivation is considered from the viewpoint of two observers moving relative to each other. The first observer is resting relative to a body and the second one is moving perpendicular to the light. It occurs in SRT that the light should "know" beforehand about observer's motion at velocity v exactly, and the momentum should be received in such a manner, that in this second system the velocity of a body be not changed, and only its mass could change. But in such a case what shall we do with Lebedev's experiments on light pressure, where at momentum transmission by light it was the observed velocity of a body, which has changed? And what will happen to the momentum, if we shall have absolutely absorbing rough (skewed) surfaces? It is also unclear from presented drawings, whether we are dealing with real transversal light or with some mystical longitudinal-transversal light (for "saving" SRT).

Rather strange in SRT is the difference in the cumulative radiation mass as a dependence on system's momentum:

$$m = \sqrt{\frac{(E_1+E_2)^2}{c^4} - \frac{(\mathbf{P}_1+\mathbf{P}_2)^2}{c^2}}. \qquad (1)$$

And if we shall change the momentum (direction) of separate photons by mirrors? In this case we shall determine the center of gravitation of a system. Where will it be localized also what will be the structure of the field closely to it? Will this center be skipping, really? Let us make use of presented SRT formula for determining the mass of cumulative radiation of two photons, flying apart of each other at arbitrary angle, and consider the radiation diverging from the same center (see Fig. 3). Then, depending on the in-pair grouping of photons, we can obtain different cumulative mass of the whole system (whether will it be necessary to introduce artificially the negative masses for "explaining" all possible variations of a mass?). And in GRT it is necessary to take into account the radiation birth pre-history for determining the localization of its center of gravitation and, besides, to take into account the whole unknown space-time structure of the electromagnetic field for correct description of a quite different phenomenon – the gravitation. Infinitely complicated procedure, really!

There are also some questions to the Compton effect theory and, in particular, to the interpretation of two key facts of the experimental curve: 1) the dissipation on free electrons being at rest; 2) the declaration of the presence of highly (?) bound electrons with the energy greater than 1 Mev (?!). For the first fact one should make the following comment. First, at real temperatures the possibility for an electron to have zero velocity is zero, and it is necessary to consider the arbitrary motion of electrons (the real distribution). In particular, the peak should be related to the most probable, rather to zero, velocity. Second, it would be interesting to confirm the effect on electron beams in all three quantities independently: in angles, energies and in a number of particles. For the second fact we note that with declared high energies it would be strange not to draw out any (even internal) electron. Probably, the

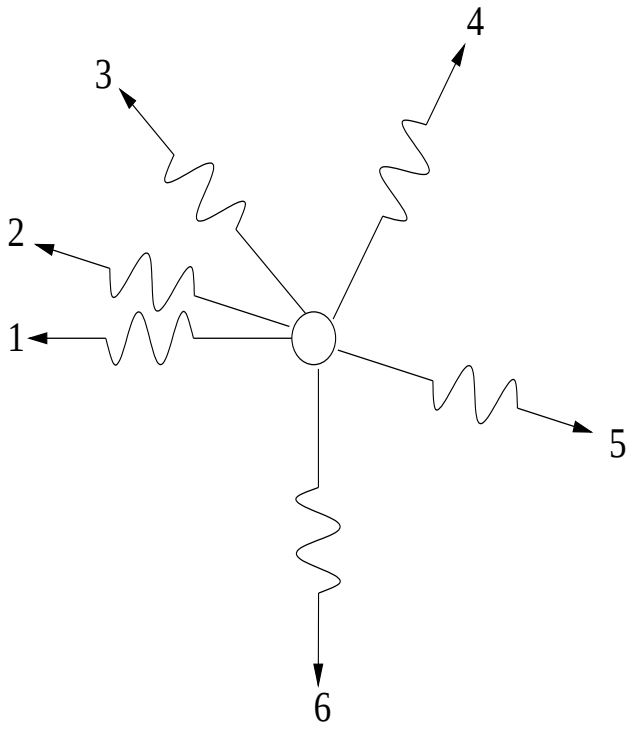

Figure 1: An indefinite mass of the photon combination.

Compton effect (as well as Mossbauer's effect) should be considered for a body (or atom) as whole from some resonance conditions. However, even in this case still remain the questions on the influence of motion of electrons in atoms and on the temperature effect on all three quantities measured in a single (!) experiment.

The relativists permanently emphasize that the Newtonian mechanics does not describe anything as compared to SRT. For example, in the book [16] the so-called Thomas precession is considered (which represents the effect of turning a rod in SRT as the manifestation of the "relativity of simultaneity"). It is also alleged in this book that in the Newtonian mechanics the gyroscope always keeps its attitude. However, as known from the quantum mechanics, the electron spin moment is always directed either along, or against the direction of orbital moment. That is, in the given case it is perpendicular to the orbital plane (and to the electron velocity!). And in this generally-accepted case both the Newtonian mechanics and SRT conserve the gyroscope direction perpendicular to the orbital plane. Therefore, the varying spin directions, shown in the book [16], do not meet the reality. If, nevertheless, we suppose the electron spin attitude to be slant and recall, that we have not simply a gyroscope (a rotating ball), but a charged particle that possesses magnetic moment, then in the magnetic field of a charged nucleon under an effect of forces the electron spin precession will be observed, which can be described in the classical manner (as far as it is possible to be done for microscopic world's objects). For classical description of the given phenomenon (without SRT interpretations) it is necessary to know all atomic parameters, including the attitudes of spins and moments. Moreover, in the classical case, even if the electron spin attitude is perpendicular to the orbit, the precession is possible, if the nucleon moment is not perpendicular to the orbit (the nucleon can precess too).

The use of the particles' spin concept is intrinsically inconsistent in SRT. The fact is, that at collisions the particles move relative to each other and, in addition, change their motion. And in a moving system the angular momentum (both orbital, and the spin) must, according to SRT, differ from the same quantity in a resting system. And how can the spin remain to be invariant and participate in rigorous numerical equalities (conservation laws)?

The mass conservation law, as an independent law, is confirmed by a vast amount of the experimental data. The elementary particles either do not change at all (but change their kinetic energy and the energy of their concordant electromagnetic field), or completely transform into the other particles. The photon is also a particle, which can be characterized by the velocity and frequency or by the wavelength. Simply, no arbitrary mass transformation into energy does exist.

Still remain in SRT the questions for particles with a zero rest mass. First, from relativistic expressions for energy and momentum in no way follows a rigorous transition to the case of $v = c, m_0 = 0$. How, for example, can arise a continuum of every possible frequencies ω in such a transition? Second, where do the gravitation energy (field) and the bending of space disappear, and where is their center of localization positioned at annihilation. As, for example, in the case, where from $m_0 \neq 0$ we obtain, by means of reflections, $m_0 = 0$, or we have a linear chain of sequentially annihilating and born pairs? The problem of photon's rest mass is senseless, generally speaking. The photon, as a definite particle, is characterized by some definite frequency ω. At rest ($\omega = 0$) the photon would even be not a different particle; simply, it would cease to exist. Therefore, there is no concept of photon's rest mass (as well as the concept of photon's rest energy, etc.). On the other hand, for a real photon it is quite possible to determine not only the energy and momentum, but the mass as well. In the textbook [21] the conclusion was drawn quite incorrectly, that the particles with zero rest mass can not exist in the classical physics, since for $m = 0$ any force must allegedly cause infinite acceleration. First, not any force can act on a photon with $m = 0$. For example, when the gravitation force acts, a zero mass is canceled and the acceleration remains finite. Second, both the classical mechanics and SRT do not impose principal limitations on the value of acceleration. This allows one, for example, to consider the collisions of particles and the reflection of light to be

instantaneous processes. Third, why the SRT choice is better, when under an effect of force, according to relativists' logic, the acceleration for light remains to be zero? If we appeal to intuition, then the infinite photon mass is obtained in SRT.

The field (possibly, not only electromagnetic?), as a material medium capable of transferring energy and possessing a momentum, can possess a mass as well. Hence, for the classical physics it is also not surprising at all, that some field is capable to transfer the mass. In such a case the field must participate in the classical mass conservation law, and then the mass will be conserved in any reactions. The field must also participate in the momentum and energy conservation laws, and then one can not change the classical part of these conservation laws, which relates to particles. Therefore, in the classical physics it is also not surprising at all, that the excited atom can weigh greater than unexcited one, or the body with a greater energy can possess greater mass. This additional mass is concentrated in the field, which causes particles to oscillate, to move over forceless trajectories or to kick from a particle-retaining wall. If we suppose the particles and the process of their collision itself to possess a purely electromagnetic nature, then in vacuum it is possible to use the relativistic expressions for the momentum-energy, but only from the viewpoint of unambiguous interrelations between quantities. However, one should remember here, that in this case the energy and momentum characterize the given collision process only, because they are written down, actually, with allowance for the energy and momentum of the field.

Let us make some supplementary remark. In deriving the relativistic expression for the momentum "it is proved" that the momentum should be directed along the velocity, otherwise it would be indefinite. However, this reasoning is not rigorous in any way with respect to a single particle, because in a system, where $\mathbf{v} = 0$, the direction of momentum is indefinite too. The classical expression for momentum follows from the Euclidian nature (homogeneity, isotropy) of space and from the invariance of mass. Following the minimum necessity principle, one can keep the classical expression both for the direction, and for the magnitude of particle's momentum. Then all relativistic changes will be revealed in changing the expression for energy. Simply, it is necessary to remember that for charged particles the field can also possess nonzero energy and momentum. And only the collision of neutral particles without internal degrees of freedom can be strictly elastic.

One more supplementary remark. In the book [16] (exercise 65 – "the momentum without mass") the platform on caster wheels is considered. At one of its ends the motor with accumulator is installed, which rotates, by means of a belt-driven transmission (through the whole platform), the caster wheel with vanes in water at the other end of a platform. As a result, the electrical energy of the accumulator transfers from one end of a platform into the thermal energy of water at the other end of a platform. Again, now we deal with the loss if determinacy (with non-objectivity): for "saving" SRT various observers should draw various artificial conclusions about the paths and rates of energy (mass) transfer. For example, according to SRT, the observer on a platform should assign the energy (mass) transfer to the belt-driven transmission. And if we shall leave to him open for observation only two small chunks of a belt, then in what and how this mass transfer can be confirmed experimentally? The classical physics attitude is more legible: if one body influences the second one, then the committed work is determined by the product of acting force on the relative path: $A = \int \mathbf{F} d\mathbf{r}$ or $A = \int \mathbf{F}\mathbf{v} dt$, where $\mathbf{v}$ is the relative velocity. For example, under an effect of the friction force a moving body stops. The kinetic energy of a body relative to the surface will be numerically equal to the work of the friction force and is numerically equal to the amount of released heat. These quantities are invariant (do not depend on the observation system).

Of course, all losses of objective characteristics of SRT (which are presented here only for completeness of the picture) look simply as "student's fittings" as compared to the logical gaps and contradictions existing in SRT.

3. Conclusion

The given paper is basically devoted to the criticism of relativistic dynamical concepts. Section II presents the criticism of the relativity notion. Further on, the relativistic concept of mass is discussed in detail and its criticism is also given. The inconsistency of the concept of a center of masses in SRT is indicated. Then the paper gives the criticism of the relativistic concept of force, of the transformation of forces and of the relativistic approach to various units of measurement. After this the true sense (without SRT globalization) of the invariance of the Maxwell equations is considered. The criticism of the relativistic relationship between the mass and energy is also presented in the paper. The so-called "experimental confirmations of the nuclear physics" are further criticized and some particular problems are considered in this respect. Such SRT aspects, as the radiation mass, the so-called Thomas' precession and other problems are critically discussed.

The resulting conclusion of the paper consists in the necessity of returning to the classical interpretation of all dynamical concepts. The classical interpretation of seemingly purely relativistic dynamical solutions escapes the framework of this paper and can be a subject of a separate investigation.

References

[1] D.C. Miller, "The Ether-Drift Experiment and the Determination of the Absolute Motion of the Earth," *Revs. Mod. Phys.*, **5**, 203 (1933).

[2] D. Sutliff, "Why Physics Cannot Assume the Relativity of Motion or an Infinite Universe: Problems with Special and General Relativity," *Physics Essays*, **4**, 217–222 (1991).

[3] H. Montanus, "Special Relativity in an Absolute Euclidian Space-Time," *Physics Essays*, **4**, 350–356 (1991).

[4] D.G. Torr and P. Kolen, "Misconceptions in Recent Papers on Special Relativity and Absolute Space Theories," *Found. Phys.*, **12**, 265–284 (1982).

[5] W.A. Rodrigues,Jr. and J. Tiomno, "On Experiments to Detect Possible Failures of Relativity Theory," *Found. Phys.*, **15**, 945–961 (1985).

[6] V.A. Atsyukovsky, "Critical Analysis of the Basis of the Relativity Theory," Zhukovskiy, 1996.

[7] B.I. Peshchevitskiy, "Relativity Theory: Alternative or Fiasco," *Galilean Electrodynamics*, **3**, 103–105 (1992).

[8] J.P. Claybourne, "The Reciprocity of Einstein's Special Relativity Theory," *Galilean Electrodynamics*, **3**, 68–71 (1992).

[9] C.K. Whitney, "Finding Absolution for Special Relativity Theory," *Galilean Electrodynamics*, **7**, 23–29 (1996).

[10] C.K. Whitney, "The Twins, the Mesons, and the Paradox," *Apeiron*, **4**, 104–109 (1997).

[11] R.P. Feynman, R.B. Leighton, M. Sands, "The Feynman Lectures on Physics," V.1, Addison-Wesley, London, 1963.

[12] L.D. Landau and E.M. Lifshitz, "The classical Theory of Fields," Nauka, Moscow, 1988.

[13] P.G. Bergmann, "Introduction to the Theory of Relativity," Inostrannaya Literatura, Moscow, 1947.

[14] E. Schmutzer, "Relativitätstheorie - Aktuell," Mir, Moscow, 1981.

[15] V. Fock, "The Theory of Space, Time and Gravitation," Pergamon Press, London, 1959.

[16] E.F. Taylor, J.A. Wheeler, "Spacetime Physics," W.H.Freeman and Company, San Francisco, 1966.

[17] L.I. Mandelshtam, "Lectures in Optics, Relativity Theory and Quantum Mechanics," Nauka, Moscow, 1972.

[18] N.U. Frankfurt, A.M. Frank, "Optics of Moving Body," Nauka, Moscow, 1972.

[19] V.A. Ugarov, "Special Relativity Theory," Nauka, Moscow, 1969.

[20] D.V. Sivukhin, "Optics," Nauka, Moscow, 1985.

[21] I.V. Savel'ev, "Physics," v.1, Nauka, Moscow, 1989.

[22] S.N. Arteha, "On the Basis for Special Relativity Theory," *Galilean Electrodynamics*, **14**, Fall (2003).

[23] S.N. Arteha, "On Frequency-Dependent Light Speed," *Galilean Electrodynamics*, **15**, Spring (2004).

[24] S.N. Arteha, "On Notions of Relativistic Kinematics," *Galilean Electrodynamics*, **15**, Fall (2004).

[25] S.N. Arteha, "On the Basis for General Relativity Theory," *Spasetime & Substance*, **3**, N;. 5(15), 225–233 (2002).

[26] S.N. Arteha, "Some Remarks to Relativistic Kinematics," *Spasetime & Substance*, **4**, No. 3(18), (2003).

[27] D.V. Sivukhin, *Electricity*, (Nauka, Moscow, 1977).

Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 182–184

"QUANTUM GRAVITY": AN OXYMORON

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Received August 10, 2003

I prove that "quantum" and "Einsteinian gravity" are incompatible concepts. Accordingly, the graviton is a mere object of science fiction.

1. Introduction

The innumerable and learned efforts during seventy years to create a quantum formulation of general relativity have only beaten the air – *et pour cause*, as we shall see. On the other hand, it is evident to any unprejudiced scientist that definite reasons must be at the root of this failure.

First of all, whereas "particles and fields exist *within* space-time, gravity *is*, in essence, space-time" [1]. This implies, in particular, that the physical meaning of the so-called critical (or "Planckian") quantities $M_0 \equiv (\hbar c/G)^{1/2} \approx 10^{-5}$ g, $L_0 \equiv (\hbar/M_0 c) \approx 10^{-33}$ cm and $T_0 \equiv L_0/c$ is rather uncertain ("unsicher"), as it was emphasized by Rosenfeld many years ago [2]. Rosenfeld was specially qualified to formulate a judgment of that kind because the above constants came forth through an extension to the quantized ***linear*** approximation of general relativity (whose substrate is Minkowski spacetime – and this is an essential point) of a deep method, created by Bohr and Rosenfeld for the quantum electromagnetic field [3].

The current belief that below time T_0, length L_0, and mass M_0 the Einsteinian theory of gravitation loses its validity is fully unfounded. Indeed, its justification by means of a bold application of more or less sophisticated quantum techniques does not possess any sound basis. General relativity has nothing to do with the classical field theories in Minkowski spacetime, or in "rigid" Riemann-Einstein spacetimes.

Further, "there is no experiment that tells us that the quantization of gravity is necessary" [1].

Finally, the fictive nature of the so-called gravitational waves [4] is sufficient to render meaningless *any* quantization program of general relativity.

(The physical inconclusiveness of the theoretical approaches that make use of supplementary dimensions of spacetime curled up with a radius comparable to the "Planckian" length L_0, does not need to be emphasized. The opinion according to which the superstring theory provides a possibility for a consistent quantum theory of gravity is destitute of a rational foundation).

For a bibliography on quantum gravity see e.g. the *References* of the papers [5] and [6].

2. Two observational results

Two recent papers of *observational* nature (see [5] and [6]) raise serious doubts on the existence of the quantum fluctuations of the metric tensor of general relativity at the "Planckian" scales, i.e. at the scales of the constants L_0, M_0, T_0 (see sect.**1**).

Lieu and Hillman [5] remark that if the above fluctuations really existed, the instant t of an event could not be determined more accurately than a standard deviation $\sigma_t/t = a_0(T_0/t)^\alpha$, where a_0 and α are positive constants ~ 1. (Analogously, the distances should be subject to an ultimate uncertainty $c\sigma_\tau$.) As a consequence of a cumulative effect of this "Planck-scale phenomenology", we should have a complete loss of phase of the e.m. radiation emitted at large distances from the observer. The conclusion of the abstract of paper [5] runs as follows: "Since, at optical frequencies, the phase coherence of light from a distant point source is a necessary condition for the presence of diffraction patterns when the source is viewed through a telescope, such observations offer by far the most sensitive and uncontroversial test. We show that the HST [Hubble Space Telescope] detection of Airy rings from the active galaxy PKS1413+135, located at the distance of 1.2 Gpc secures the exclusion of all first order ($\alpha = 1$) quantum gravity fluctuations with an amplitude $a_0 > 0.003$. [...]"

Ragazzoni, Turatto and Gaessler [6] write: "[...] We elaborate on such an approach [i.e., the approach

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of [6], which was subject to some criticism] and demonstrate that such an effect would lead to an apparent blurring of distant point sources. Evidence of the diffraction pattern from the HST observations of SN1994D and the unresolved appearance of a Hubble Deep Field galaxy at $z = 5.34$ lead us to put stringent limits on the effects of Planck-scale phenomenology."

I shall now prove rigorously that, from a sound theoretical standpoint, there are *no* quantum fluctuations of the fundamental tensor of general relativity.

3. The oxymoron

As is was explicitly pointed out by Pauli [7], in quantum mechanics the time t is a "*gewöhnliche Zahl* (« *c-Zahl*")", i.e. it coincides with the time of classical physics. Thus, time t is *not* a dynamical variable represented by an operator of the Hilbert space of the physical states. Analogously, also the co-ordinates of the points of three-dimensional physical space are parameters, and not dynamical variables; only the co-ordinates q_r, $(r = 1, 2, \ldots, n)$ of the n degrees of freedom of a holonomic system are dynamical variables represented by Hilbert operators.

In the customary (Lorentzian) quantum field theory, a given field is described by a set of m, say, operators φ_s, $(s = 1, 2, \ldots, m)$, that are functions of the spatial points and of the instants of time.

In *general* relativity the fundamental spacetime interval $\mathrm{d}s$ is given by

$$\mathrm{d}s^2 = g_{jk}(x^0, x^1, x^2, x^3)\mathrm{d}x^j\,\mathrm{d}x^k, (j, k = 0, 1, 2, 3), \quad (1)$$

where the coefficients g_{jk} of the metric do *not* represent a classical field in the conventional meaning, but characterize directly the spatiotemporal structure – in other terms, *they "are" the spacetime itself*. (The co-ordinates x^0, x^1, x^2, x^3 are mere *labels* of the spacetime points, fully devoid of any metrical meaning).

If we write the Minkowskian $\mathrm{d}s^2$ of a Lorentzian quantum theory making use of a system of general co-ordinates x^0, x^1, x^2, x^3, we obtain obviously an expression of the following kind:

$$\mathrm{d}s^2 = h_{jk}(x^0, x^1, x^2, x^3)\mathrm{d}x^j\,\mathrm{d}x^k, (j, k = 0, 1, 2, 3), \quad (2)$$

and we see that, according to the basic axiom previously emphasized [7], the functions $h_{jk}(x) = h_{kj}(x)$ are non-operators, i.e. they are (necessarily!) customary functions ("c-numbers") of the co-ordinates x^0, x^1, x^2, x^3.

We realize now that the project of a theory such that the g_{ik}'s of the *exact* (non-approximate) formulation of *general* relativity are promoted to the role of operators of a function space implies a blatant contradiction with the above axiom of quantum theory.

"Quantum" and "[Einsteinian] gravity" are incompatible concepts, and thus the expression "quantum gravity" is actually an oxymoron.

4. Recapitulation

The classic spacetimes of quantum theories are the following:

i) the Euclidean-Newtonian substrate of Galilean group of transformations;

ii) the Minkowskian substrate of Lorentzian group of transformations;

iii) any given, "rigid" Riemann-Einstein spacetime.

We have correspondingly:

i) the nonrelativistic quantum mechanics of the systems with a finite number of degrees of freedom;

ii) the Lorentzian quantum theories – and the quantized *linear* approximation of GR (Pauli, Rosenfeld);

iii) Dirac's equation for a particle in a fixed Riemann-Einstein spacetime.

The known quantum formalisms can have a definite physical sense *only* under the condition that the above spacetimes are described by the customary non-operator entities. Consequently, the meaning of *any* quantization program of GR is doomed to a whimsical arbitrariness, because it implies necessarily some *operator* characterization of spacetime itself.

APPENDIX

A puffing operation

As it has been recalled in sect.**1**, the constants L_0, M_0, T_0 pertain, rigorously speaking, *only* to the quantum *linearized* version of GR. In the current astrophysical literature they are denominated "Planck constants". Why? The reason is simple. In 1899 Planck [8] remarked that with suitable combinations of the *fundamental* constants G, c, h, it is possible to obtain the following four "natural" *units of measure*:

unit of length: $\sqrt{\frac{Gh}{c^3}}$,

unit of mass: $\sqrt{\frac{ch}{G}}$,

unit of time: $\sqrt{\frac{Gh}{c^5}}$,

unit of temperature: $\frac{1}{k}\sqrt{\frac{c^3h}{G}}$,

where k is Boltzmann's constant. (Actually, in the paper of 1899 Planck wrote b in lieu of h, and a in lieu of h/k.)

Clearly, "measure units" and "physical constants" are *distinct* concepts. I suppose that the astrophysical community is perfectly aware of this trivial difference.

To qualify with Planck's name the constants L_0, M_0, T_0 has been a tricking operation with the aim to dignify with a great name three constants having a very dubious meaning.

"–Warum willst du dich von uns allen
Und unsrer Meinung entfernen?–
Ich schreibe nicht euch zu gefallen,
Ihr sollt was lernen!"
J.W.v. Goethe

References

[1] F.I. Cooperstock, *Ann.Phys.*, **282** (2000) 115.

[2] L. Rosenfeld, in *Einstein-Symposium, 2.-5. November 1965*, herausgegeben von H.J. Treder (Akademie-Verlag, Berlin) 1966, p. 185.

[3] N. Bohr und L. Rosenfeld, *Dan.Mat.Fys.Medd.*, **12** (1933) Nr.8. See also L. Rosenfeld, *Physica*, **19** (1953) 859, and E. Corinaldesi, *Suppl.Nuovo Cimento*, **10** (1953) 83.

[4] A. Loinger, *Nuovo Cimento* B, **115** (2000) 679; Idem, *Spacetime & Substance*, **3** (2002) 129; Idem, *ibidem*, **3** (2002) 145. See also A. Loinger, *On Black Holes and Gravitational Waves*, (La Goliardica Pavese, Pavia) 2002, Part II.

[5] R. Lieu and L.W. Hillman, *Astrophys.J.Letters*, **585** (2003) L77–L80.

[6] R. Ragazzoni, M. Turatto and W. Gaessler, *Astrophys.J.Letters*, **587** (2003) L1–L4.

[7] W. Pauli, "Die allgemeinen Prinzipien der Wellenmechanik", in *Handb.d.Physik* Band V, Teil *1* (Springer-Verlag, Berlin, *etc*) 1958, p. 60, footnote[1]. See also P. Carruthers and M. M. Nieto, *Revs.Mod.Phys.*, **40** (1968) 411.

[8] M. Planck, *Berl. Ber.*, (1899) 440. See also Planck's book "Vorlesungen über die Theorie der Wärmestrahlung," (J. A. Barth, Leipzig) – first edition 1906, fifth edition 1923.

Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 185–187

ON RELATIVITY AND QUANTIZATION IN PLANETARY COSMOGONY

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Received September 8, 2003

In the work the existence of relativism and quantization in cosmogony are discussed.

Planetary cosmogony is still far away from the applications of GR mechanical ideas and the ideas of quantization. It is classical. Though one can think that this situation will not stay stable forever. Really, there are some indications for this fact as it seems. First indication — the existence of a class of round orbits of a testing body laying in the equatorial area of a rotating central body and stay stable relatively to vector elements of orbit (angular momentum) and (Laplas vector). In reality let's consider the well-known problem of GR mechanics, Lense-Thirring problem, i.e. the problem of finite motion of a testing body with mass in the field of rotating central body with mass . Consideration will be developed on the basis of detailed metric of Fock's first approximation for a liquid rotating body [1]

$$ds^2 = \left[c^2 - 2U\left(1+\frac{\xi_0}{m_0c^2}\right) + \frac{2U^2}{c^2} + \right.$$
$$\left. + \frac{4\gamma}{7m_0c^2}(\vec{S_0}\vec{\nabla})(\vec{S_0}\vec{\nabla}\frac{1}{r})\right]dt^2 -$$
$$-\left(1+\frac{2U}{c^2}\right)d\vec{r}^2 + \frac{8}{c^2}(\vec{U}d\vec{r})dt, \qquad (1)$$

where

$$U = \frac{\gamma m_0}{r}, \quad \vec{U} = -\frac{\gamma}{2r^3}[\vec{r}\vec{S_0}], \quad \xi_0 = \frac{8}{3}T_0 + \varepsilon_0, \qquad (2)$$

S_0 is angular momentum of a sphere; T_0 is kinetic energy of a rotating body; ε_0 is energy taken with negative sign of mutual attraction of the parts of the body. We will remind that

$$(\vec{S_0}\vec{\nabla})(\vec{S_0}\vec{\nabla}\frac{1}{r}) = -\frac{S_0^2}{r^3} + \frac{3(\vec{r}\vec{S_0})}{r^5}. \qquad (3)$$

In contrast to different metrics of the first approximation, metric (1) describes Schwarzschild task [2], and also considers nonlinear from element, that is important in consideration of Lense-Thirring problem. Now the Lense-Thirring Hamiltonian can be written as [1]:

$$H = mc^2 + \frac{P^2}{2m} - mU -$$
$$-\frac{1}{c^2}\left(\frac{P^4}{8m^3} + \frac{3P^2U}{2m} + \frac{\xi_0}{m_0}mU^2\right) -$$
$$-\frac{2\gamma}{c^2}([\vec{S_0}\vec{\nabla}\frac{1}{r}]\vec{p}) - \frac{2\gamma m}{7m_0c^2}([\vec{S_0}\vec{\nabla}][\vec{S_0}\vec{\nabla}\frac{1}{r}]), \qquad (4)$$

where $\vec{P} = \partial L/\partial\vec{P}$ - momentum of a particle, L - Lagrange function. Equations of motion take the form

$$\dot{\vec{M}} = \frac{2\gamma}{c^2r^3}[\vec{S_0}\vec{M}] - \frac{12\gamma m}{7m_0c^2r^5}(\vec{S_0}\vec{r})[\vec{r}\vec{S_0}], \qquad (5)$$

$$\dot{\vec{A}} = (4E + 6mU + \frac{m}{m_0}\xi)\frac{\vec{\nabla}U\vec{M}}{mc^2} + \frac{2\gamma}{c^2r^3}[\vec{S_0}\vec{A}] +$$
$$+\frac{6\gamma(\vec{S_0}\vec{M})}{mc^2r^5}[\vec{r}\vec{M}] - \frac{6\gamma}{7m_0c^2r^5}\{S_0^2[\vec{r}\vec{M}] -$$
$$-\frac{5}{r^2}(\vec{S_0}\vec{r})^2[\vec{r}\vec{M}] - 2(\vec{S_0}\vec{r})[\vec{S_0}\vec{M}] + 2(\vec{S_0}\vec{r})[\vec{P}[\vec{r}\vec{S_0}]]\}, \qquad (6)$$

where $\vec{M}$ and $\vec{A}$ are vector elements of the orbit,

$$\vec{M} = [\vec{r}\vec{P}], \quad \vec{A} = [\frac{P}{m}\vec{M}] - \frac{\gamma m m_0}{r}\vec{r},$$
$$A = \gamma m m_0 e = ae, \qquad (7)$$

E is nonrelativistic energy, e is eccentricity of the orbit. From equations (5) and (6) one can see that vectors $\vec{M}$ and $\vec{A}$ change slowly with time and take part in two types of motion: evolutionary and periodical. Let's consider the evolutionary motion of a material particle with mass m_0 in gravitational field of a rotating liquid massive sphere with mass. For that let's apply to

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equations (5) and (6) the asymptotical method of nonlinear mechanics — method of averaging (by Newton period T). Then differential equations of the first approximation of the asymptotical method (equations of evolutionary motion) take the form

$$\frac{d\vec{M}}{dt} = [\vec{\Omega}\vec{M}], \frac{d\vec{A}}{dt} = [\vec{\Omega}\vec{A}], \tag{8}$$

where

$$\vec{\Omega} = \frac{\partial \bar{H}}{\partial \vec{M}} = \frac{3m\alpha^4\vec{M}}{M^3M_0^3c^2} + \frac{m^2\alpha^4}{m_0M_0^3M^3c^2}\left\{2\vec{S}_0 - \right.$$

$$\left. - \frac{3m(\vec{M}\vec{S}_0)}{7m_0M^2}\vec{S}_0 + \frac{6m(\vec{M}\vec{S}_0)^2}{7m_0M^4}\vec{M}\right\} -$$

$$-\frac{3m^2\alpha^4\vec{M}}{m_0M_0^3M^5c^2}\left\{2(\vec{M}\vec{S}_0) + \frac{mS_0^2}{7m_0} - \frac{3m(\vec{S}_0\vec{M})^2}{7m_0M^2}\right\}. \tag{9}$$

Here $M_0 = \frac{M}{\sqrt{1-\frac{A^2}{a^2}}}$ - invariant of the system. Averaged Hamiltonian

$$\bar{H} = mc^2 - \frac{m\alpha^2}{2M_0^2} + \frac{1}{c^2}\left\{\left(\frac{15m\alpha^2}{8M_0^2} - \frac{m}{m_0}\xi_0\right)\frac{\alpha^2}{M_0^2} - \right.$$

$$-\frac{3m\alpha^4}{M_0^3M} + \frac{m^2\alpha^4}{m_0M_0^3M^3}\left[2(\vec{S}_0\vec{A}) + \frac{mS_0^2}{7m_0} - \right.$$

$$\left.\left. -\frac{3m}{7m_0M^2}(\vec{S}_0\vec{M})(\vec{S}_0\vec{M})\right]\right\}. \tag{10}$$

Now let's consider the question of stability to absolute values of vector elements $\vec{M}$ and $\vec{A}$. As it is easily seen from equations of evolutionary motion (8) and (9) conservation of absolute values of vectors and follows

$$M = const, A = const. \tag{11}$$

It is clear that from the above indicated evolutionary motion of a material particle is stable to absolute values of vector elements $\vec{M}$ and $\vec{A}$. On the other hand orbital stability of motion of a material particle in the field of a rotating body follows from (11). Really, under orbital stability of motion of a material particle is implied the property of oscillating ellipse to conserve in any moment its form and sizes close to the form and sizes of not disturbed Kepler ellipse, defined for the initial point of time. The form and sizes of the ellipse are characterized by the value of eccentricity and the value of focal axis 2a. In case when there are no secular terms defining e and a in the formulas then according to definition elliptical motion has orbital stability. From equations (11) the consequences follow exactly

$$a = const, e = const. \tag{12}$$

i.e. orbital stability of motion of a material particle in the field of a rotating massive liquid sphere. Let's now introduce new type of stability in GR mechanics — stability to vector elements itself $\vec{M}$ and $\vec{A}$, i.e. we will ask for realization of the following conditions of motion stability of a material particle

$$\vec{M} = const, \vec{A} = const. \tag{13}$$

i.e. for that types of motion general equations (8) should take the form

$$\frac{d\vec{M}}{dt} = 0, \frac{d\vec{A}}{dt} = 0 \tag{14}$$

or

$$[\vec{\Omega}\vec{M}] = 0, [\vec{\Omega}\vec{A}] = 0. \tag{15}$$

From here follows that stable to vector elements $vecM$ and $vecA$ in Lense-Thirring task is the class of circular orbits lying in ecvatorial area of a rotating body. Second indication — the law of planetary distances of O.Yu. Schmidt in cosmogony [3]. According to O.Yu. Schmidt: the difference between square roots from distances of two planets from the Sun is a constant value

$$\sqrt{R_{n+1}} - \sqrt{R_n} = \sqrt{R_n} - \sqrt{R_{n-1}} \tag{16}$$

or

$$\sqrt{R_n} = R_0 + bn, n = 0, 1, 2, ... \tag{17}$$

where b - is constant difference between adjacent square roots. Presume that in the Solar system all orbits have circular form and all planets of the Earth type have the same mass we can rewrite Schmidt's law, i.e. equations (16), (17), through the angular momentum using the well-known formulae:

$$R_n = \frac{M_n^2}{m\alpha}, \ \alpha = \gamma m m_0 . \tag{18}$$

Then the Schmidt's law of planetary distances takes the form:

$$M_{n+1} - M_n = M_n - M_{n-1} \tag{19}$$

$$M_n = \sqrt{m\alpha}(R_0 + bn). \tag{20}$$

This way, Schmidt uses the law of quantization of motion angular momentum in his well-known cosmogonic theory actually. Here we will also add that N.G. Chetaev (1902–1959) — corresponding member of Academy of Sciences of the USSR, distinguished mechanist and mathematician, the author of fundamental works and ideas in the field of stability theory and analytical mechanics [4], [5], expressed once a remarkable thought: "Stability — phenomenon principally general and as it seems, should be performed in general laws of nature." Developing regularly this idea N.G.Chetaev came in particular to the hypothesis of quantization of stable orbits of dynamics. According to N.G.Chetaev

only some exclusive trajectories can be stable - analogously to the fact how it is in quantum mechanics: stable are only exclusive orbits of electrons [4]. We can notice that in cosmogony there was much said about the role of rotation (of the sun and planets) both self and orbital in the evolution of the Solar system. Though only taking into account mechanics of GR makes this task determined because rotation is connected with specific field — vector gravitational field with vector potential $\vec{U}$. The third indication — the equation of relativistic spin-spin and magnetic-magnetic interactions in planetary cosmogony. For the Solar system spin-spin interaction of the system "Sun + planet" has the same order as magnetic-magnetic interaction. Actually, according GR, the addition to the Hamiltonian, taking into account interaction of two angular moments (self rotations of "Sun + planet") has the form [1]:

$$\delta H = \frac{\gamma}{c^2}([\vec{S}\vec{\nabla}][\vec{S_0}\vec{\nabla}\frac{1}{r}]) - \frac{2\gamma m}{7m_0c^2}([\vec{S}\vec{\nabla}][\vec{S_0}\vec{\nabla}\frac{1}{r}]), \quad (21)$$

where $\vec{\nabla}$ operator $\partial/\partial\vec{r}$. Magnetic-magnetic interaction in the system "Sun - planet" gives additional term in Hamiltonian [6]

$$\delta H' = \frac{(\vec{M}\vec{M_0})r^2 - 3(\vec{M}\vec{r})(\vec{M_0}\vec{r})}{r^5}. \quad (22)$$

In case one uses Blacket's equation [7] it can be easily shown that for the Solar system interactions (21) and (22) have the same order

$$\vec{M} = -\beta\frac{\sqrt{\gamma}}{2c}\vec{S}, \quad (23)$$

where β is numerical coefficient. The fact that spin-spin and magnetic-magnetic interactions in planetary system have the same order takes an important meaning. According to Alfven [8] magnetic-magnetic interaction plays an important role in the evolution of the Solar system. Now it is clear that we should take into account spin-spin interaction also.

References

[1] M.M.Abdil'din. "Mechanics of gravitational theory of Einstein," Almaty, 1988, 198 p.

[2] L.D. Lanau, E.M.Lifshitz. "Field theory." Moscow, 1973, 502 p.

[3] O.Y.Schmidt. "Four lectures on the theory of the Earth formation. Selected works." Geophysics and cosmogony, publ. by Nat. Acad.Sci.USSR, 1960, 102p.

[4] V.V.Belecki. "Articles on the motion of space bodies." Publ. by "Nauka," Moscow, 1977.

[5] N.G.Chetaev. "Stability of motion. Works on analytical mechanics." Publ. by Acad.Sci. USSR, 1962.

[6] V.V.Batygin,I.N.Toptygin. Collection of problems on electrodynamics. Moscow, 19700, 503 p.

[7] Abdil'din M.M. "On Interpretation of the Einstein Equations in General Relativity." *Gravitation & Cosmology*, Vol. 5 (1999); No. 3(19), pp 219–221.

[8] H.Alfven, H.Arrenius. "Evolution of the Solar system." "Mir," Moscow. 1979.

Spacetime & Substance, Vol. 4 (2003), No. 4 (19), pp. 188–192

SOME REMARKS TO RELATIVISTIC EXPERIMENTS

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Received September 8, 2003

The paper presents some comments to the experimental substantiation of the relativity theory. Such key experiments of the special relativity theory (SRT), as the Michelson-Morley, Kennedy-Thorndike, Ivese-Stilwell experiments, and some related problems are considered in detail. Also the experiments of the general relativity theory (GRT), such as the Hafele-Keating and Pound-Rebka experiments, are discussed.

1. Introduction

Traditionally, standard textbooks begin with a description of the allegedly then existing crisis of physics and experiments that preceded the generation and establishment of the special relativity theory (SRT). However, there exists the opinion [1] that SRT was originated as a pure theoretical "breakthrough" having no need of any experimental substantiation. The author does not agree with such a view, for physics is destined primarily to explain the really existing world and to find interrelations between observed (measurable) physical quantities. The logical contradictoriness of SRT and the general relativity theory (GRT) was proved in papers [2-7]. In spite of the fact that earlier [2] the groundlessness of the relativity theory in baseline relativistic experiments has already been demonstrated, in the given paper we shall make some additional critical comments and consider in more detail some known relativistic SRT and GRT experiments for the methodical purposes. In so doing we shall not consider in detail the experiments pertinent only to electromagnetism or various particular hypotheses of ether (this theme is huge in itself). Instead, we shall analyze exclusively some general experiments affecting the essence of RT kinematics and dynamics.

Section 2 gives the comments to the experimental substantiation of RT. Section 5 contains the conclusions.

2. Comments to the Experimental Substantiation of RT

We shall begin with some general remarks. For the sake of justice it is necessary to note, that the principle of relativity has never been verified to a maximum experimental accuracy even for the mechanical phenomena. If we believe in the absence of all-penetrating ether, then similar properties can be attributed to the gravitational field. How the observer on the Earth wouldn't be moving (in the rectilinear uniform motion or in circular motion over the Earth surface), the gravity force will change in magnitude or in direction, which can be detected from the comparison of quantitative regularities in the experiments. Therefore, the declared hypothetical experiments could be performed only in the absence of gravitation or in the case of strictly symmetrical distribution of the whole Universe relative to the observation point. But in the presence of moving bodies such a strict "compensation" of gravitation could take place at a single point only. In all real cases one can observe the absolute changes of the state (velocity, acceleration, etc.) relative to the point of space the investigated object passes through at the given instant.

Now we make a supplementary remark concerning the ether. Frankly speaking, the inventing, apart from the "absolute emptiness" (not possessing physical properties), of the other concepts of "physical vacuum"-type (possessing physical properties) is unfair with respect to many previous researchers, since for similar concepts there exists already a special term – "the ether." Only for the ether the problem was stated: to explain all experiments on a simple and clear model or "to go out from the scene." The further development of physics introduced another practice (remember the dualism of light, the quantum mechanics, etc.): the contradictory properties have become to be simply postulated as a fact without explanation and without a real visual model. Let, for example, to be existing a two-component liquid model for describing the contradictory properties of superfluid helium (the flow without viscosity through a capillary and the presence of viscosity at rotation). The reality is far from the model, but the model really works (it is useful). And only the theory of ether was unfairly ruined by the relativists. Though, in fact, for all ether models declared unreal by relativists there

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were analogies in the nature. For example, there is nothing surprising in the fact that the speed of light can remain the same as the ether density changes: the speed of sound in air for $T = constant$ does not depend on the air density as well. There is nothing unnatural also in the fact that the ether density can essentially (60000 times only) increase near the Earth surface as compared to the open space (the density of the atmosphere grows many orders of magnitude greater). The Stokes model is a model without the atmosphere. The mathematical complications of the model (the supposition on a vortex-free incompressible motion) are pure at anything here: the real (nature describing) solution can occur to be close to that found by Stokes (simply it is more difficult to find the true stringent solution without simplifications). For the sake of justice we note that rather well-developed concepts of ether are existing now [8,9].

Now we proceed to more specific issues and make brief comments to some well-known experiments. The aberration in the empty space without SRT was analyzed in [2] from the viewpoint of both corpuscular and wave theory. The result will be the same from the viewpoint of the motionless ether theory as well. The full ether entrainment by a medium is not clear in the case, if the medium density gradually decreases (for example, in gases). By this reason nobody (except the relativists) has seriously discussed the full ether-entrainment hypothesis. It was still Fresnel, who introduced the coefficient indicating, that only partial entrainment of ether can be supposed in the optically transparent media. It does not virtually (to achieved accuracy) change the aberration in filling a tube with water, which had been shown by Fresnel himself. (Note that if the observation is non-vertical, it is necessary to take into account the angle of refraction of beams in filling media.) The only case, where it is lawful to discuss the full ether entrainment hypothesis, is the case of optically opaque media (metals). Maybe it was Hertz, who intuitively felt this situation, when he refused from the very beginning to consider the optical phenomena from the viewpoint of his electrodynamics (by this reason the application of his theory for dielectrics is invalid).

The Michelson-Morley experiment and its analogs do not contradict the Galileo principle and have been considered in detail from the empty space viewpoint in [2]. For the sake of justice one should note that the Michelson experiment and its analogs (in spite of the disputes concerning the instrument structure and the theory) have always confidently, with allowance for possible errors, given a nonzero velocity of the ether wind [10,11]. (Marinov [12,13] and Silvertooth [14] have found a correct velocity relative to a relic radiation.) Only at instrument screening with a metal casing the result occurred to be close to zero one. Not accepting the ether theory unconditionally, nevertheless, we recall for the sake of objectivity, that all instruments are vacuumed now (i.e. made a locally closed system). And, for example, the local speed of sound in airplane's saloon will remain constant (independent on the wind outside) even at supersonic motion of an airplane. The ether point of view does not contradict the obtained results: Fresnel's entrainment for metal bodies is complete (Hertz's electrodynamics is valid for metals), and, hence, the ether is resting locally inside the metal casing relative to an instrument, and searching for the ether wind inside is senseless. The Rowland experiment has actually proved that, from the ether theory viewpoint, the ether is fully entrained by a metal, and from the viewpoint of Galileo's principle of relativity he proved the moving charges equivalence to the current. Roentgen, Euchenwald and Wilson have actually obtained in their experiments the Fresnel coefficient of entrainment in dielectrics. These results do not contradict Galileo's principle of relativity, since the light (or the field) passes a part of its path in the emptiness between atoms and the other part of a path – when the light is absorbed and re-emitted by atoms. Trouton and Noble's experiment does not also contradict Galileo's principle of relativity for the empty space. Note that the Fresnel entrainment coefficient can always be slightly corrected in such a manner, that the experiments of both 1-st and 2-nd order be confirmed to a practical accuracy (if there is no metal screening).

Contrary to the judgement of [15], the Kennedy-Thorndike experiment does not principally differ in anything from the Michelson-Morley experiment, since the accuracy of measuring the interferometer arms is always lower, than the wavelength of used light. If one proceeds from the experiment tasks (on detecting the effect of the interferometer system motion on the speed of light), then author's estimate of $v \leq 15$ km/s is more adequate, than that stated in the textbooks, though it is incorrect too (see below). The great stability in temperature, beginning with some limit, does not matter, because at any $T = constant$ $(T \neq 0)$ always exist temperature fluctuations and oscillations of a lattice. Of most importance is the fact, that various speeds of light $c(\omega)$ (the only possible distinction – see [2]) have not been compared for various frequencies ω, which would be impossible to be done in a similar experiment. Besides, for the empty space all classical considerations for inertial systems remain valid; that is, Galileo's principle of relativity [2] is met in this case. The general notion about metal screening for the ether model is applicable to this experiment as well. Thus, all listed experiments have no relation even to detecting the motion of the Earth.

Now we shall pass to the Ivese-Stilwell experiment. Note that Ivese himself was a SRT opponent and explained the experiment from the ether theory viewpoint (which means that such an interpretation is also possible). Generally, it is characteristic of SRT to "put" everything into a personal "pile" (probably, in order to

look more solid) or to "tie up" SRT with all theories (even not completely verified), pretending that if SRT "sinks," then "all science will also sink." Actually, the Ivese-Stilwell experiments, even in the ideal case (with neglecting real features of a process) would determine not the transversal Doppler effect, but the Doppler effect for two directions close to 0° and 180°, i.e. the effects close to longitudinal ones. These experiments are indirect, since the value of a relativistic correction is a calculated quantity (which is compared, in addition, from various regions, which results in the additional asymmetry). The experiments [16] have shown essential systematic deviations from the relativistic expression (up to $60 \pm 10\%$). Therefore, the effect can be determined not so much by the Doppler expression, as by the feature of reactions in beams. In addition to mentioning the other alternative experimental data [16,17], we shall give some criticism of considered experiments. Relativists describe the experiment in such a manner, as if the transversal Doppler effect is perceived from one point of an installation at some certain time instant (the time of passage through the middle perpendicular). Actually, the perceived signal is an integral sum from various regions of radiation for various time, and these regions are, in addition, not perpendicular to the motion (where, for example, the aberration has gone?). That is, the studied effect represents some "composite mean value" between two longitudinal Doppler effects. Besides, the theory (and the formulas) in SRT are presented for plane-parallel waves, but in fact we have point-like sources (the spherical waves) at these distances. As a result, the displacement into the red area will be observed (a greater time of action of such a displaced line), and the effect should depend on the distance to the observation point. Thus, the given experiment can not be unconditionally attributed to the experiments confirming the relativistic time slowdown in SRT. Some relativists [1,18] distinguish three key experiments (by Michelson, Kennedy-Thorndike and Ivese-Stilwell) which should unambiguously result in the Lorentz transformations (a basis for SRT). We see, however, that all these three experiments are not evidential. SRT "hangs in the emptiness" even from the experimental point of view.

Note that the light dispersion was discovered long ago in the open space [19] (the dispersion of $c(\omega)$ in vacuum was suggested in paper [3]). The example can be mentioned, where the radiation lines have appeared in 2 months after detecting the X-ray flash [20], which can also have relation to light dispersion in vacuum.

Make some more general comment. The erroneousness of the relativity theory is in no way related with the presence or absence of all effects the SRT tries to describe (and speculate on this). By the "reasons," which are claimed in SRT, no extraordinary effects can simply exist. If, nevertheless, some effect is still observed, then it is necessary to search for another real reason (explanation, interpretation) for it. Each theory contains a series of "if"'s, which should be verified experimentally. For example, whether the running of some processes in the object can change, when its velocity really (!) changes? It can, in principle. For example, the first "if" is as follows: the ether exists; the second "if" is as follows: some process depends on the velocity relative to this ether. But in this case the relative velocity of two observation systems will be pure at anything. If the first and second system are moving to opposite sides at the same velocity v relative to the ether, then similar processes in these systems will proceed similarly. If, however, the third system moves to the same side as the first one, but at velocity $3v$ relative to the ether, then, in spite of the same relative velocity $2v$, the processes in the third and first systems will differ. In the given case the principle of relativity itself (and, the more so as, SRT) is violated. Such a situation is also possible, in principle, but should be verified in the course of experiments only.

One more remark concerning the experimental results. The scattering of data in each of experiments on measuring the speed of light is high, as a rule. And the small tolerances declared in SRT are obtained only after some certain statistical processing (that is, after fitting under desirable results). This has already resulted in discomfiture: the most probable value of the speed of light, declared by relativists, had been twice changed with obvious escaping the limits of declared tolerances (see [21]).

The classical law of addition of velocities has relation to the translational motion of bodies only. If, however, there exists also the oscillational motion, then, generally, no definite words can be said about the total velocity (even for non-relativistic velocities). For example, the velocity of hammer impact against a tuning fork has no relation to the velocity of propagating waves. Consider one more example. Let a long rod be moving over the surface of water perpendicular to its length at velocity v_1, and the point-like source excites the waves in front of a rod. Then these waves will pass some part of the path in water, which rests relative to the rod, at velocity v_2, and another part of a path – in water, which rests relative to the shore. As a result, the wave velocity will lie between $v_2 + v_1$ and v_2 (and will be, generally speaking, a function of the distance to a source). The next example. The local speed of sound relative to the airplane in airplane's saloon with holes will depend on the velocity of a steady airflow inside airplane's saloon (some analog of Fresnel's entrainment coefficient).

Rather strange is a typical "increase of accuracy" at statistical data processing in SRT. This means that the data are artificially selected and those dependencies are analyzed, which certainly meet the given theory. First, the most probable values of various physical quantities can be completely unbound causally with

each other even in separate acts of interaction (recall the distinction between the true value and the mean, most probable or effective value in a particular process of measurement). Second, for essentially nonlinear expressions from the equality of mean (or effective) values it is rather difficult to extract the declared relations for true (instantaneous, or causally bound) quantities. Such an analysis of the data (allegedly confirming SRT) is met nowhere. Third, the attention should be paid to the following mathematical facts: 1) the statistical averaging of a periodic function with unknown period over the other (untrue) period can give a zero result (or a quantity lower than true one); 2) the attempt to determine a periodic dependence by selecting an incorrectly guessed or shifted harmonics gives zero ($\int \cos(\omega t)\cos(\omega_1 t + \alpha)dt = 0$) or an underestimated quantity. Possibly, the incorrect statistical data processing is just the reason, by which, in spite of considerable deviations of each of separate measurements from a zero level, rather small oscillations of quantities are obtained in some experiments (of Michelson type) after statistical processing.

For completeness of the picture (because of the relativity theory unity declared by relativists) we shall present, in addition to [5], some critical comments to the experiments. It is rather strange, that in some cases the relativists declare the equivalence of description (of Sagnac's experiment, for example) both within the SRT framework, and with using the non-inertial system within the GRT framework. In the other cases, however, contrary to the declared equivalence of the gravitational field and the non-inertial nature of a system, the SRT gives an inadequately low result (for example, for the Mercury perihelion displacement).

The Hafele-Keating experiment on the gravitation dependence of time contradicts the interpretation of the Pound-Rebka experiment, where the generator was considered to provide the same frequency at any altitude. The gravitational displacement is treated in [15] from the energy point of view, but where the time slowdown in the gravity field has vanished in this case? The statistical analysis in the subsequent (temperature) Pound-Rebka experiments is a rather doubtful matter: if the effect is attributed to a sample as a whole, then what is the role of temperature oscillations (the scattering of velocities inside a sample) in determining the shift of frequencies (aging?!) with the temperature? The attempt to get rid of the relativistic "discordance" was undertaken in [22]. However, the "explanation" with the help of an elevator, given in that paper, is completely groundless; therefore, the comparison of the Pound-Rebka experiment with the Hafele-Keating experiment can not be considered in favor of the gravitational change in the operation of the watch. The fact is that all formulas in SRT and GRT are local. Actually, in the aforementioned paper the relativists try "to create" mentally a unique object by means of infinitely rapid signals. Whether the fact, that I set moving the receiver now, can influence the photon that will be received from the Alpha-Centaur 4 years later? Certainly, it can not! In fact, SRT also considers the signal (a photon and its influence) to propagate at the speed of light. Therefore, we should not consider the elevator velocity at the initial instant to be zero at "explaining" the Pound-Rebka experiment. On the contrary, we should impart to a freely falling elevator such a velocity (it does not influence a remote photon), that at the photon reception instant the "instrument" (perceiving an atom) be at the same place, as a real resting atom, and has a zero velocity too. It is clear that the Doppler effect will be pure at anything in this case, since it depends only on velocity, rather than on acceleration. Both atoms will be at the completely equal position, and the only distinction will lie in the fact that one of the atoms has a support from below, whereas the second one – does not. But, in fact, if the support is removed instantaneously, nothing can change (according to the Doppler effect). However, for obtaining this final state the photons could be sent from different "depths," i.e. the effect would be different for the same state (place). Therefore, the observed effect represents the influence of just changed properties of a photon itself, rather than of the receiving atom position. It is just the photon, which becomes red (but not "the place of reception becomes blue"), which can be quite probably described in terms of the energy loss and changing a real frequency of a photon (rather than changing of observed frequency). The GRT's "explanation" of this displacement in terms of "bluing the energy levels of an absorbing atom," given in [22], is rather doubtful by the other reasons as well. Since the question is here about an individual atom, the given effect can not be a "characteristic of the place" (GRT's watch). For example, the atoms of gas are always (except the collision instant) in the free falling state, and no displacement at the given place would be observed. In liquids and solid bodies the atoms are moving too (even for $T \to 0$). Therefore, instead of distinct displacement of a line (this effect is highly sensitive even to velocities of some cm/s), the complete spreading of a line would be observed. But in any case not a "universal gravitational GRT effect" is obtained [22], but the effect, which depends on particular non-relativistic mechanisms participating in the given process. The manipulation with mathematical symbols can not be considered as the "explanation" in physics. (For example, the masslessness condition in the third "explanation" of [22] is nothing else, but a hypothesis). The fact, that the Pound-Rebka experiment's explanation is correct in the energy terms exactly (the change of energy signifies the change of a photon frequency), is clear from following mental experiment (see Fig. 1). Let an electron and positron be annihilated in the gravitational field $\mathbf{g}$ underneath. Let the two obtained photons be reflected

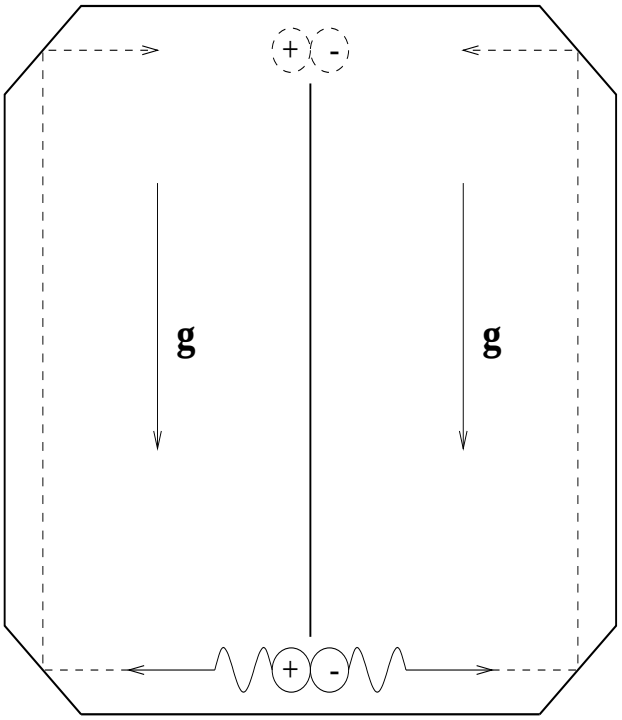

Figure 1: Perpetuum mobile of GRT.

upwards. Let now the birth of a pair of particles to take place again overhead. If the energy of photons did not change at their rising in the field of gravity (recall a customary air on the Earth), then how could we without energy consumption lift the particles in the field of gravity to a high altitude (i.e. we have imparted them some additional potential energy)? Is it a perpetuum mobile, really?

3. Conclusion

The article contains both the general comments on the experimental substantiation of the relativity principle, on the theories of ether, on statistical data processing and others, and the specific critical discussion of the aberration phenomenon, the Michelson-Morley, Kennedy-Thorndike, Ivese-Stilwell and other experiments. The complete inadequacy of interpretations of these experiments within the SRT framework is demonstrated in the paper. Such GRT experiments, as the Hafele-Keating and Pound-Rebka experiments, are discussed at the end of the paper. This article demonstrates a full experimental groundlessness of the RT.

References

[1] N.U. Frankfurt, A.M. Frank, "Optics of Moving Body," Nauka, Moscow, 1972.

[2] S.N. Arteha, "On the Basis for Special Relativity Theory," *Galilean Electrodynamics*, **14**, Fall (2003).

[3] S.N. Arteha, "On Frequency-Dependent Light Speed," *Galilean Electrodynamics*, **15**, Spring (2004).

[4] S.N. Arteha, "On Notions of Relativistic Kinematics," *Galilean Electrodynamics*, **15**, Fall (2004).

[5] S.N. Arteha, "On the Basis for General Relativity Theory," *Spasetime & Substance*, **3**, No. 5(15), 225–233 (2002).

[6] S.N. Arteha, "Some Remarks to Relativistic Kinematics," *Spasetime & Substance* **4**, No. 3(18), (2003).

[7] S.N. Arteha, "On Notions of Relativistic Dynamics," *Spasetime & Substance* **4**, (2003).

[8] V.A. Atsyukovsky, "General Etherodynamics," Energoatomizdat, Moscow, 1990.

[9] A.I. Zakazchikov, "Returning of Ether," Sputnic+ Company, Moscow, 2001.

[10] D.C. Miller, "The Ether-Drift Experiment and the Determination of the Absolute Motion of the Earth," *Revs. Mod. Phys.*, **5**, 203 (1933).

[11] F.F. Michelson, F.G. Pease and F. Pearson, "Repetition of the Michelson-Morley Experiment," *J. Opt. Soc. Amer.*, **18**, 181–182 (1929).

[12] S. Marinov, *Czech. J. Phys.*, **24**, 965 (1974).

[13] S. Marinov, *Gen. Rel. Grav.*, **12**, 57 (1980).

[14] E.W. Silvertooth, *Specul. Sc. and Technol.*, **10**, 3 (1986).

[15] E.F. Taylor, J.A. Wheeler, "Spacetime Physics," W.H. Freeman and Company, San Francisco, 1966.

[16] L.A. Pobedonostsev, Ya.M. Kramarovsky, P.F. Parshin, B.K. Selesnev, A.B. Beresin, "Experimental Determination of the Doppler Shift of Hydrogen Lines on Beams of H_2^+ Ions in the Energy Region 150–2000 KeV," *Journal of Technical Physics*, **59**, No. 3, 84–89, (1989).

[17] K.C. Turner, H.A. Hill, *Bull. Amer. Phys. Soc.*, **8**, 28 (1963).

[18] H. Robertson, "Postulate Versus Observation in the Special Theory of Relativity," *Rev. Mod. Phys.*, **21**, 378–382 (1949).

[19] V.A. Bunin, "Eclipsing Variable Stars and the Problem on the Light Speed Dispersion in Vacuum," *Astronomical Journal*, **4**, 768–769, (1962).

[20] V.N. Komarov, "Universe Visible and Invisible," Znanie, Moscow, 1979.

[21] G. Rozenberg, "Speed of Light in Vacuum," *Uspekhi Fizicheskih Nauk*, **48**, 599–608, (1952).

[22] L.B. Okun', K.G. Selivanov, V.L. Telegdi, "Gravitation, Fotons, Clocks," *Uspekhi Fizicheskih Nauk*, **169**, 1141–1147, (1998).

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An abstract (within 20 lines) must be submitted. This one should be concise and complete regardless of the paper content. Include purpose, methodology, results, and conclusions. References should not be cited in the abstract. The abstract should be suitable for separate publication in an abstract journal and be adequate for indexing.

If the argument of an exponential is complicated or long, "exp" rather than "e" should be used. Awkward fractional composition can be avoided by the proper introduction of negative degrees. Solidus fractions (l/r) should be used, and enough enclosures should be included to avoid ambiguity in the text. According to the accepted convention, parentheses, brackets, and braces are in the order { [( )] }. Displayed equations should be numbered consecutively throughout the paper; the number (in parentheses) should be to the right of the equation.

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Each figure must be cited in numerical order in the text and must have figure legend.

Tables should be typed as authors expect them to look in print. Every table must have a title, and all columns must have headings. Column headings must be arranged so that their relation to the data is clear. Footnotes should be indicated by reference marks ^{1}, ^{2} etc. or by lowercase letters typed as superiors. Each table must be cited in the text.

The Editorial Council accepts also response on papers, published in the Journal. They should be no more than 1 journal page in length and should not contain figures but only to refer to the already published materials. But they can contain the formulas. The recalls are publishing in section "Discussion."

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The title of paper is permissible not to indicate. It is permissible to give only the initial page number of a paper. The format of the reference list is as indicated below.

References

[1] F.W. Stecker, K.J. Frost, *Nature*, **245**, 270 (1973).

[2] V.A. Brumberg, "Relativistic Celestial Mechanics", Nauka, Moskow, 1972 (in Russian).

[3] S.W. Hawking, in: "General Relativity. An Einstein Centenary Sutvey", eds. S.W. Hawking and W. Israel, *Cambr. Univ. Press*, Cambridge, England, 1979.

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