An Interpretation of Relativistic Mechanics

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ABSTRACT. The present article reports on the finding of the principal basis behind relativistic mechanics. From the independence of the speed of light upon the velocity of the light source it is concluded that the vacuum consists of the light carrying ether. The second crucial conclusion is that the elementary particles represent specific excitations of some parts of rigid ether. The motion of the electron in the atom undergoes multiple reflections, and the electron trajectory represents a broken line. The forces of inertia are conditioned by the properties of the ether excitation that is identified with the physical body. The constancy of the transverse dimensions of freely moving particles and bodies is determined by de Broglie waves. The invariants in the theory of relativity are the transverse dimensions of moving objects and the speed of light.

RÉSUMÉ. L'article porte sur la recherche de la base principale de la mécanique relativiste. A partir de l'indépendance entre la vitesse de la lumière et la vitesse de sa source on conclut que le vide consiste en un éther qui transporte la lumière. La seconde conclusion principale est que les particules élémentaires représentent des excitations de certaines parties d'un éther rigide. Le mouvement d'un électron dans l'atome inclut des réflexions multiples et la trajectoire de l'électron représente une ligne brisée. Les forces d'inertie sont définies à partir des propriétés de l'excitation de l'éther qui à son tour est identifiée au corps physique. La constance des dimensions transverses des particules et des corps en mouvement libre est déterminée par des ondes de de Broglie. Les invariants de la théorie relativiste sont les dimensions transverses des objets en mouvement et la vitesse de la lumière.

1 Introduction to the theory of relativity

What determines the speed of light in vacuum? The answer is simple: presently this question is not raised in the scientific literature. In the scientific, it must be emphasized, for the upholders of the formal approach are generally against futile disputations, and when asked, address the inquirer to Einstein's special relativity [1], which has been extensively tested and survived an uncommonly forceful attack of its opponents. At the foundation of this theory lie two assumptions (in fact postulates): one posits that the value of the speed of light, i.e. its instantaneous speed, is the same in all the inertial frames of reference.

One may see that this postulate is too complicated to be a basis for theory. It might be more expedient to raise a simpler assumption, i.e. that the speed of light is independent on direction in only one inertial reference system. Yet, even such assumption cannot form the basis of a physical theory, since it involves an unexplained consistency, namely, when a source of light moves at any velocity, the propagation speed of emitted light is always the same. Without elucidating this consistency, we cannot advance in understanding the relativistic mechanics. Note that there are many evidences in favor of this consistency, first of all from the double stars observations. Therefore, we would like to consider this consistency at some greater elaboration.

Suppose a light source is moving at a constant velocity in vacuum relative to a freely moving solid object (an inertial reference frame). Let us ask ourselves, how could the velocity of emitted photons be the same at different velocities of the light source? Or, figuratively speaking, how is the light source "aware" of the speed at which it must emit the photons (even a single photon), if it is not "aware" of its own velocity. The light source, the photon, and the solid object are analogous to a source of sound, the sound, and the sound receiver. It is unlikely that the above postulate can be acceptable in the case of the propagation of sound.

To answer the question posed we follow the principle of causality. Generally, two participants, the light source and adjacent space, might be involved in the light emission. In order for the photons to have the same velocity at different velocities of the light source, a second participant has to be taken into account. The space remains to be responsible for light speed. *Thus, the vacuum is a continuous medium that determines the velocity of photon propagation*. We arrive at the important conclusion of the presence of the luminiferous aether ("light-bearing aether" or ether) in space. Preliminary results have been presented elsewhere [2]. In the following, we will show the crucial role of ether in a modified version of the theory of relativity.

2 Where are the arguments against the existence of ether ?

Our conclusion of the presence of ether in space agrees with Lorentz's theory of ether [3]. In the following, we will briefly consider some experiments in order to elucidate and counter the objections against the existence of ether. Let us begin with Fizeau's experiment, where a monochromatic light beam was propagated along the direction of water flow, and another beam against it [4]. Measurements showed that the time of light propagation opposite to the water flow is greater than that in the direction of the flow. The explanation of the Fizeau results based on special relativity has become widely accepted. However, Lorentz suggested the true cause of this phenomenon, namely, the drag of secondary emission dipoles by the moving water medium.

To comprehend this issue, we take into account the lower speed of light propagation in transparent media than in vacuum. The decrease in the speed of light occurs because the electrons of atomic groups of the medium respond to the change in the electric and magnetic fields during light propagation. Due to high electron susceptibility, atoms absorb energy from the incident light wave. The amount of absorbed energy is proportional to the intensity of the electric field (the Stark effect) and magnetic field (the Zeeman effect). When the intensity of a light wave (or more precisely, of the train of waves) decreases, in other words, when the wave train, without its anterior part that has been absorbed by the atomic group, starts moving away from the atoms -- the excess oscillation energy of the electron systems returns, to some extent, to the posterior part of the train. Such partial temporary light absorption causes a short temporary delay of light (but not a decrease in the speed of light).

The time of delay can be easily assessed:

$$\tau = l / c_1 - l / c = l\,(n - 1) / c\,, \qquad (1)$$

where l is the length of water course, c is the speed of light in vacuum, c_1 is the average velocity of light energy transfer in water, $n = c / c_1$. In Fizeau's experiment, during such light absorption, the light energy was transferred by the water flow, which affected the average rate of the light energy transfer. In addition, the oppositely directed light beams passed through water paths of different lengths: the beam directed against the flow passed through a longer watercourse in the tube than the beam propagating down the flow. These considerations are sufficient to calculate the average velocity of light propagation in a water stream, which is equal to $c_1 + k\,v$, where v is the water flow velocity, and the calculated coefficient k corresponds to the expression for Fresnel's drag coefficient $k = 1 - 1 / n^2$, see [5]. In turn, calculations using Fresnel's coefficient correspond to the experimentally measured light velocity.

In the well-known experiment of Hoek [6], water in the tube was motionless and the entire apparatus along with the interferometer was rotated by an arbitrary angle. The position of interference fringes remained unchanged during the rotations. The propagation time for each beam in water against the ether wind will be described by expression $l / (c - v) + \tau$, and in the direction of the ether wind by $l / (c + v) + \tau$. In the final expression for the time difference in light propagation, τ will not appear, therefore no effect could be present. In the same manner, we can analyze Airy's experiment on light aberration [7]. Based on this, we may conclude that *matter does not drag ether*.

Among the experiments, confirming the validity of the special relativity, the Michelson – Morley experiment holds a central position. This experiment is referred to whenever an empirical evidence for special relativity is asked for. The initial objective of that experiment was to detect the ether wind [8]. Though the expected effect is rather minor (of the second order of magnitude relative to v / c), the very first tests conclusively showed no effect whatsoever [9]. The only acknowledged conclusion derived from the subsequent more precise measurements was that the ether wind does not exist. The hypothesis of body contraction during its motion in the ether, proposed by Fitzgerald, see [10], and Lorentz [3] in order to save the concept of ether, has been tagged after the advent of special relativity as a bizarre and forced notion. Such dismissal seems unjustified: indeed, the ether wind runs through the entire body and every atom of it, thereby possibility of its effect on the shape of that body or atom cannot be disregarded.

To question such dismissal of the hypothesis of body contraction, consider the following argument proposed by Lorentz [11] even before the discovery of the electron and atomic nucleus:

"Surprising as this hypothesis may appear at first sight, yet we shall have to admit that it is by no means far-fetched, as soon as we assume that molecular forces are also transmitted through the ether, like the electric and magnetic forces of which we are able at the present time to make this assertion definitely. If they are so transmitted, the translation will very probably affect the action between two molecules or atoms in a manner resembling the attraction or repulsion between charged particles. Now, since the form and dimensions of a solid body are ultimately conditioned by the intensity of molecular actions, there cannot fail to be a change of dimensions as well."

After the discovery of the nucleus by Rutherford and the development of the primary concepts of atom structure, the electromagnetic nature of molecular forces has become clear. One might expect that the categorical dismissal of ether wind would be challenged, based on the clear and compelling arguments of Lorentz. One might also chance upon such arguments by himself. This has not happened however.

3 On solid ether and elementary particles

In the course of time, several hypotheses have been suggested as to the state and structure of ether. It should be recalled, that an early (before the advent of special relativity) hypothesis of mechanical ether was based on the concept of solid ether. However, it could not explain why there is no ether resistance to the motion of celestial bodies. As a result, this hypothesis was eliminated from scientific discourses. We need to return to the issue.

Note that there are no longitudinal waves in ether resulting from particle collision. Therefore, we may conclude that all reactions between elementary particles occur in *rigid solid ether*. It seems to me, the properties of ether near massive cosmic objects might be different.

The question remains how particles (and thus objects) can move in an absolute rigid medium. Since a particle of light, the photon, can somehow travel through the solid ether without a loss of energy, being some sort of a local excitation of the ether, therefore any other particles moving in the ether must also be some excited states of the ether. Thus, we arrive at the second crucial conclusion: *elementary particles represent specific excitations of the ether*.

Such an approach allows us to interpret qualitatively several well-known properties of elementary particles. First of all, the very term "elementary particles" cannot be perfectly reconciled with our conclusion; this term can be adopted only provisionally. Since photons are characterized by energy, thus any other particles must have energy in any state, including the state of no onward movement. That is to say, they must be characterized by *rest energy*. In addition, an excitation cannot occur, even temporarily, in null volume. Therefore *the interactions between particles are not point but volume interactions that may be accompanied by formation of transient complexes*. The fact that a particle possesses an intrinsic mechanical moment (spin) also conforms to this conception.

An excitation of a certain ether region cannot be isolated from adjacent regions due to the continuity and rigidity of ether. During excitation of a certain ether region by an electric or magnetic field on approach of a particle, e.g. a photon, the volume of that region cannot change due to ether rigidity. Nevertheless, we cannot exclude the possibility of deformation due a minor displacement of ether within that volume. Indeed, the infinity of force lines of electric and magnetic fields allows us to suppose an extremely small relative displacement of part of ether along the lines of force e.g. of an electric field, or reorientation of structural components within that part. If the lines of force are closed, the reorientation or displacement of ether components will not affect the total volume of these components, but then a special state of ether around these lines will be manifest. This special state may be attributed to the closed force lines of a magnetic field. These arguments lead to the conjecture that the excitation of an ether region occupied by a certain particle is related to coherent displacements or reorientation of some smaller parts of ether.

4 Frames of reference

Inasmuch as particles are excitations of the ether, *all bodies and cosmic objects are just certain states of ether*. It is well known that every reference frame must be rigidly associated with at least one solid object therefore there can be no frame of reference linked to any part of ether. However, we may posit such a reference frame K, where the cosmic radiation is symmetrical. Then we may assume that the speed of light in such frame of reference is the speed of light propagation in stationary ether.

In the reference frame so defined, the speed of light is in any case independent of its direction. However, the frame K is still not rigidly associated with ether; therefore, the absolute isotropic frame of reference seems to be no more preferable for measurements. Based on the wave properties of moving particles, we will demonstrate the correctness of the special relativity postulates, and therefore the equivalence of inertial frames of reference.

5 Physical meaning of the wave function

The motion of a particle, e.g. electron, in ether medium is possible under the condition of an appropriate excitation in the ether. We can compare this excitation to the de Broglie wave. Indeed, in the familiar experiments on the diffraction of electrons (or other particles) there occurs the simultaneous interaction of every electron, undergoing diffraction, with the atomic planes of the crystal. From our standpoint, this means that *the moving electron appears as a wave excitation of the ether in a volume comparable to the volume of the entire crystal*. This conclusion contradicts the generally accepted probabilistic interpretation of the de Broglie waves. The probabilistic interpretation, suggested by Born, attained popularity after the failure of the "naive" interpretations treating the de Broglie waves as material ones.

To resolve this contradiction, let us first consider the well-established view on an electron's behaviour in an electric field. The probability of electron appearance in the entire volume equals to unity:

$$\int |\psi|^2 dV = 1. \quad (2)$$

This equality allows for normalizing the wave function.

Consider the simplest case of an electron found in a one-dimensional potential well having width *l* with infinitely high potential walls (the transition to a three dimensional well is quite simple). The Schrödinger equation for a stationary case is:

$$d^2\psi / dx^2 + (2m / \hbar^2)E\psi = 0 . \quad (3)$$

The boundary conditions for the general solution $\psi = a\,sin(kx + b)$, where $k = (2mE / \hbar^2)^{1/2}$, yield: $b = 0$, $k\,l = n\,\pi$ ($n = 1, 2, 3$ ...).

The latter equality gives discrete energy values:

$$E = (\pi^2 \hbar^2 / 2ml^2)n^2. \quad (4)$$

Noteworthy, in this way the physical value E is obtained without interpreting the nature of the wave function, let alone normalizing it. Finally, the expression for the normalized wave function is:

$$\psi = (2/ l)^{1/2} sin(\pi nx / l). \quad (5)$$

It follows from this expression that the probability of the electron's appearance decreases as it approaches the potential well's boundaries. At the very boundary, the probability is zero. Note that the probabilistic interpretation of the wave function is that the square of the function's absolute value determines the probability distribution for the electron's coordinates. This particularly entails that at any moment in time, the electron has certain coordinates, that is, it occupies an infinitesimally small (more precisely zero) volume, which remains conserved in time. However, it follows from Heisenberg's uncertainty relation that the uncertainty of the electron's momentum value should be unlimited. Therefore, the energy of the electron cannot have a definite value. A second argument against the prevalent interpretation is that the probabilistic distribution of the electron coordinates means negating the consistency in the electron's motion in the energy well or in an atom; most importantly, it means negating the law of momentum conservation. For example, in the case above, the moving electron may not reach the wall of the potential well and turn back. Therefore, the probabilistic interpretation of the wave function, whether normalized or not, doesn't seem to have a physical meaning.

We suggest another interpretation. *The wave excitation in the ether provides for the electron's motion, therefore, this excitation must be described by the electron's kinetic energy.* Thus, the normalizing integral for *determining the amplitude of the wave function* in the example above would be:

$$\int |\psi|^2 \, dV = E \,. \tag{6}$$

This equality entails a dimensionality of the wave function. Note that formulas analogous to that describe the energy of electric and magnetic fields. The normalized wave function takes the form:

$$\psi = [\pi\hbar n / (ml^3)^{1/2}] \, sin(\pi n x / l). \tag{7}$$

This type of correction to the normalization of particles' wave functions does not significantly alter the mathematical apparatus of quantum mechanics. The mathematical apparatus also utilizes the principle of superposition of states, which also does not appear to have a clear physical meaning. This principle will be considered in the following section.

6 On the motion of electrons in the atom

Our approach to the laws of electron motion in atoms principally differs from the approaches generally accepted in the quantum theory. In order to clarify this distinction, we will discuss the well-known thought experiment of the idealization of electron diffraction on crystals. In this experiment, a rarefied bundle of electrons passes through two slits made in an electron-impermeable flat screen. According to the prevalent interpretation, every electron passes simultaneously through both slits, without splitting in two parts. To avoid contradiction in the interpretation and premises of the superposition principle, the quantum theory utilizes a probabilistic interpretation and the existence of electron trajectory is denied.

Note that the two slits are completely isolated regions on the screen surface plane. In the case of diffraction on a crystal, there is not a single plane within the crystal volume where there can be such two regions isolated from each other by an electron-impermeable part of the plane. For that reason, we believe this “thought experiment” is erroneous, and *the acceptance of the principles of probability and superposition in the quantum theory is ungrounded.*

The primary consistency of an electron’s behaviour in an atom is that the electron moves in space continuously.

The second consistency is that the translational motion of an electron along a circular orbit is impossible for the following reason. Suppose an electron wave is situated on a circular orbit. Then its front will be oriented along a radial line passing through the nucleus, therefore the nucleus’ electric field cannot cause a rotation of the wave front. However, without a rotation of the front, movement along a circular orbit is impossible. This is the reason why the electron movement along an elliptical orbit is also impossible. Thus, *the wave nature of the moving electron leads to a partial, and perhaps even complete, rectification of the electron’s motion.*

Thirdly, the velocity of an electron decreases when the electron moves away from the nucleus. But not to zero, since its wavelength increases due to the dependence of the de Broglie wave length of the electron on the velocity. Consequently, the motion of the electron in the atom undergoes multiple reflections from barriers formed by the electric field of the nucleus, and the electron trajectory is thus a broken line.

Obviously, the electron wave, due to its circuit continuity, must simultaneously encompass the entire orbit. Therefore, for a stationary atom state during reflection, *the phase of the incident wave must be greater than the phase of the wave reflected from the point of incidence by* $2\pi n$.

The impossibility of the electron’s energy and orbital moment taking arbitrary values can be clarified by the following consideration. Let the electron’s velocity increase under an external disturbance. Then the length of the broken line orbit must decrease due to the reduction of the de Broglie wavelength. At the same time, the recoil of the wave from the nucleus’ potential field must take place at a greater distance from the nucleus, since the electron having a greater velocity must withdraw further from the nucleus. The same discrepancy will appear when the electron velocity decreases as compared to its velocity at the stationary atom state. These considerations demonstrate the necessity of quantizing the energy and orbital moment of the atom.

7 Invariant

Free motion of particles is accompanied by plane de Broglie waves. Assume a particle moving uniformly in a certain direction, e.g. along the X-axis. The wave phase in transverse plane YZ does not depend on the distance to X-axis. Acceleration of the particle along X-axis may be considered as result of the specific collision with another particle moving along X-axis. A transient complex created during collision moves freely. There are two variants, first is that the transformation of two plane waves proceeds in the direction along X-axis only.

In this variant, the transverse dimensions of the particle are not changed after acceleration; the second variant is not considered here. Then the transverse dimensions of solid bodies are also independent of their velocity. In special relativity, as we know, the constancy of transverse dimensions followed from the impossibility of detecting the "absolute" motion.

The independence of the transverse dimensions of solid bodies on their velocity allows us to *introduce the transverse dimensions of standard solid as an invariant*. We can express the transverse dimension s of a body, moving with a certain constant velocity v along the X-axis of the reference frame K, where the speed of light c is independent of direction, that is, c is the speed of light in the ether. The expression for s will be as:

$$s = (c^2 \Delta t^2 - v^2 \Delta t^2)^{1/2}, \tag{8}$$

or in differential form:

$$ds = (c^2 dt^2 - v^2 dt^2)^{1/2}\,. \tag{9}$$

We will later show that the value of the speed of light, appearing in our invariant expression, is also an invariant. The parameter s (and ds) so determined, differs from the familiar invariant used in special relativity, since in our invariant we use light propagation only for measurement of the transverse dimensions of the moving body.

8 On time dilatation and length contraction in motion

The invariant s allows us to introduce, in the familiar fashion, the proper time in any other inertial reference frame K', determined for example by periodical reciprocal movements of light normal to the X'-axis. A clock in the reference frame K' will go more slowly when observed from the reference frame K, since the light beam of that clock will move along a triangle's hypotenuse and not along a cathetus of constant length.

In contrast to the transversal dimensions of a solid body, the longitudinal dimensions depend on its velocity. This is because the fact that in a solid changing its orientation, such as in the Michelson-Morley experiment, no deformation occurs. This means that the object's structure does not depend on its spatial orientation, therefore all the forms of ether excitations are conserved – be that particles or electromagnetic interactions. Therefore, in the K frame, the entire route travelled by an electromagnetic disturbance between any two interacting atoms A and B of a solid, directly and reversely, will be the same when atoms A and B are positioned along the X-axis or across to it.

In that case, the entire route of a light signal in the reference frame K from atom A to atom B and back will be also independent of the orientation of the two atoms. This accounts for the null result of the Michelson-Morley experiment, and explains why the longitudinal dimensions of a solid in the reference frame K will be shorter than the transversal dimensions. For the case of constancy of the transverse dimensions, it is easy to obtain the well-known formula $l = l_0 (1 - v^2/c^2)^{1/2}$.

9 On the postulates of the special theory of relativity

After introducing time as above, we can now show the correctness of the second postulate of special relativity about the constancy of the speed of light in all inertial frames of reference. All calculations will be performed in the reference frame K of the stationary ether. In the inertial reference frame K', the speed of light, for example, propagating along the axis Y', will be by definition: $c' = dy'/dt'$. Since $dy = dy'$, then for a beam of light associated with a clock of the reference frame K', we shall obtain in the reference frame K:

$$dy' = (c^2 dt^2 - v^2 dt^2)^{1/2} \tag{10}$$

To determine time intervals in the reference frame K', we can use the expression for time dilation in the frame K:

$$dt' = dt\,(1 - v^2/c^2)^{1/2}\,. \tag{11}$$

Then we obtain for the speed c' the required value: $c' = dy'/dt' = c$.

For the same purpose, but in the case of the beam propagation in the clock of the reference frame K' along the axis X' we can calculate the speed $c' = dx'/dt'$ by using the expression for time dilation in the reference frame K

$$dt' = dt(1 - v^2/c^2)^{1/2} \tag{12}$$

and the expression for longitudinal shortening

$$dx' = dx(1 - v^2/c^2)^{1/2}\,. \tag{13}$$

Again, we obtain c' equal c. The same result is obtained by simple calculations in the reference frame K needed to determine the unidirectional propagation of light in the reference frame K' using two clocks initially synchronized at the same location.

We will now discuss in detail the effects of ether wind on the workings and synchronization of two clocks necessary to measure any velocity of motion. Let the reference frame K' move at some velocity v_0 relative to the reference frame K, and let there be two identical clocks in the reference frame K' initially situated at the same location B on the X'-axis. At the moment $t_0 = 0$ by both clocks' readings, the clocks will be driven with the same small velocity to points A and C, located on the X'-axis at the equal distances l_0 from point B. The clock driven to point A (hereafter referred to as the "A clock") moves with a velocity v_1 relative to the reference frame K, while this velocity is less than v_0, whereas the "C clock" moves at a velocity v_2 greater than v_0. The A clock will arrive at point A at the moment $t_A = l_0\gamma_0/(v_0 - v_1)$ according to the clock in the reference frame K and, as an effect of the ether wind, will show a different time: $t_A' = l_0\gamma_0\gamma_1/(v_0 - v_1)$. Here we have introduced $\gamma_n = (1 - v_n^2/c^2)^{1/2}$ with n equal 0, 1, or 2, and have taken into account the length contraction and time dilation. For the C clock, the time of arrival would be $t_C = l_0\gamma_0/(v_2 - v_0)$, and the clock will show the time $t_C' = l_0\gamma_0\gamma_2/(v_0 - v_2)$. It can be seen that the readings of the clocks are different at the moment of arrival at their destinations. These shifts in the clocks' readings result in that the time of the light motion in the reference frame K' from point A to point C is equal (as can be easily calculated) to the time of light movement in the opposite direction, while the calculated speed of light equals c for both directions.

It is important to note that in order to confirm the second postulate of special relativity about the constancy of the speed of light, we had to deduce and then utilize a series of conclusions having a clear physical meaning. Notably, in the opinion of Landau and Lifshitz [12], this postulate follows from the principle of relativity according to which all physical laws are the same in all inertial frames of reference. It is not easy to confirm experimentally the principle of relativity (the first postulate of special relativity) in the approximation of v^2/c^2. A theoretical confirmation of the first postulate is, as we see, no easier than of the second. In agreement with the above opinion, we may conclude that one of the laws, namely:

$$c = dy / dt = dy' / dt' = const\,, \tag{14}$$

is uniformly manifest in different frames of reference. The same can be said about electromagnetic interactions and the structure of solid bodies. Therefore, *there is little ground for doubting the correctness of the relativity principle in the approximation of* v^2/c^2. We should also note that special relativity does not take into account either the absence of the ether or its presence in space (due to the postulates accepted).

The formerly introduced invariant $ds = (c^2dt^2 - dx^2)^{1/2}$ depends on only one coordinate. Due to the validity of the equality $c = c'$ for two arbitrary inertial reference frames, we obtain for these frames the familiar equality

$$(c^2dt^2 - dx^2)^{1/2} = (c^2dt'^2 - dx'^2)^{1/2} . \tag{15}$$

This equality leads us to the Lorentz transformation.

10 On the nature of inertia

If a physical body existed in empty space, it is unclear why it resists displacement in the empty space, "what does it hold to"? According to Mach's principle, the forces of inertia appear due to the interaction of a material body with the rest of objects in the universe. From our standpoint, *the forces of inertia are caused by the properties of the ether excitation that is identified with the physical body*.

Consider the simplest case of the interaction between three identical adjacent atoms of a solid body, A, B, and C, positioned in an increasing order of their X coordinate. Equal distances AB and BC determine the sameness of all forms of electromagnetic interactions between the atoms. Let the solid body commence at some moment t_0 an accelerated motion along the X-axis. The electromagnetic disturbances dispatched by atom B toward atoms A and C will not return to atom B simultaneously as it was before the moment t_0.

Indeed, the electromagnetic signal directed at the moment t_0 toward atom A, will reach it after a time interval Δt_1, whereas the signal directed at t_0 toward atom C will reach it after Δt_2. At the second stage, the signal from atom A will travel the distance back during Δt_3, whereas the signal from C – during Δt_4. The velocity of the atoms' movement rises at the second stage, therefore Δt_4 is less than Δt_1, while Δt_3 is greater than Δt_2 . The total time of travel from atom B to atom C and back $\Delta t_2 + \Delta t_4$ is less than the total $\Delta t_1 + \Delta t_3$. Atom B is now not at equilibrium, which is now shifted toward atom A. Thus, atom B experiences a force directed against acceleration.

This example shows how there appears the force of inertia during the electromagnetic interaction in a non-deformed object. *The appearance of the force of inertia follows from the condition of the finite speed of propagation* *of any ether excitation.* The value of that speed determines the difference between the time intervals mentioned above. Since the finite speed of excitation propagation is established – it is the speed of light, and since this speed is determined by ether, then *any excitations of the ether, that is to say any particles, must exhibit inertial properties*.

11 Relativistic mechanics

An increase in the velocity of particle motion must be accompanied by an alteration in the excitation of the ether region occupied by that particle. It is known that during a linear acceleration of an electron in an electric field, the electron absorbs the energy of that field. The absorption of the electromagnetic excitation of ether by an electron takes place both at low electron velocities (relative to the speed of light) and at high velocities. *The absorption of electromagnetic excitation of ether leads to an increase in the electron's mass and energy*. Obviously, the electron cannot be accelerated to velocity exactly equal to the speed of light.

We will now derive the dependence of a particle's energy on its velocity. The single characteristic of a particle dependent on its velocity is determined by relative change of longitudinal dimension of the particle (in the second variant above-mentioned an important parameter is the ratio of particle dimensions, longitudinal and transversal). As the particle's velocity rises, its energy augments and its longitudinal dimension decreases, therefore we can represent the dependence as:

$$E = a / (1 - v^2 / c^2)^{1/2}, \tag{16}$$

where the factor a is, obviously, the particle's rest energy E_0. Comparing the particle's kinetic energy $E - E_0$ at low velocities to its expression in classical mechanics $mv^2/2$, we obtain the familiar formulas

$$E_0 = mc^2, \quad E = mc^2/(1 - v^2/c^2)^{1/2}. \tag{17}$$

According to the said above, $m/(1 - v^2/c^2)^{1/2}$ is the mass of the particle.

The momentum of a particle also depends on the particle dimension parameters. In the classical formula $p = mv$ for a particle moving along the X-axis, the constant mass may be replaced by a variable mass, thus we obtain the formula

$$p = mv / (1 - v^2/c^2)^{1/2}. \tag{18}$$

As well known, this formula can be derived by the dependence of the particle energy on its velocity. Indeed, classical mechanics gives:

$$F = m(dv / dt) = d(mv) / dt = dp / dt. \tag{19}$$

On the other hand, according to the law of energy conservation, work expended on particles' acceleration is equal to the energy they acquire, therefore we have relationships $Fdx = dE$ and $F(dx / dt) = dE / dt$, or

$$Fv = dE / dt\ . \tag{20}$$

In turn, the derivative dE / dt can be expressed as:

$$d(mc^2 / (1 - v^2 / c^2)^{1/2}) / dt. \tag{21}$$

This expression can be transformed into

$$vd(mv / (1 - v^2/c^2)^{1/2}) / \mathrm{dt}. \tag{22}$$

Thus, we obtain:

$$dp / dt = d(mv / (1 - v^2/c^2)^{1/2}) / dt, \tag{23}$$

and arrive at the expression for momentum.

The expressions for energy and momentum can be also obtained, in the familiar way, for a solid body as well as for an electron, by using the Lagrangian. Yet, corrections have to be introduced for the case of an electron. One correction is that the free motion of an electron occurs in a certain way – along a certain trajectory. Therefore, we can apply the principle of least action (Hamilton's principle) for the electron's motion.

The second correction, according to our interpretation of the physical basics, is that the Lagrangian of a free moving particle depends only on the relative volume of the excited ether region occupied by the particle. Accordingly, we can present the Lagrangian as:

$$L = a\,(1 - v^2/c^2)^{1/2}. \tag{24}$$

Here we have introduced the proportionality coefficient a equal to L in the absence of motion. Then the action S will take the form

$$S = a \int (1 - v^2/c^2)^{1/2} dt. \tag{25}$$

Comparing these expressions for the Lagrangian L at low velocities with the expression $mv^2/2$, we obtain $a = -mc^2$ and the generally established expression for the Lagrangian

$$L = -mc^2(1 - v^2/c^2)^{1/2}. \tag{26}$$

Several approaches have been proposed for deriving the formulas of relativistic mechanics on the basis of special relativity. We prefer the approach where *a complete account is given in one frame of reference.* In this approach (which is still rather unconvincing), action S is expressed as:

$$S = -\alpha \int ds = -\alpha \int (c^2dt^2 - v^2dt^2)^{1/2}, \tag{27}$$

where ds is the interval between two infinitesimally close events, and the parameter α is a constant characterizing the given particle [12]. Here the interval ds only has a mathematical meaning, since it represents the distance between two points in the imaginary four-dimensional space formed by the variables x, y, z and ct. The expression for the action differs from the one we have proposed above in that it does not have a physical meaning. In addition, the expression obtained in this method for the parameter α has the dimensions of momentum: $\alpha = mc$. These shortcomings show that the application of special relativity in relativistic mechanics remains problematic.

12 Particles in gravitational fields

One particle cannot induce around itself any deformation of ether, yet we cannot exclude the creation of some special state of ether around the particle (the pressure state). An analogy may be suggested between the special state of ether around a particle and the tension created in the crystal around the heated area.

The possible pressure in ether near the particle depends upon the distance to it. In addition, the ether state has some additional properties similar to those of the gravitational field, namely: the additive property and the impossibility of shielding by any set of particles. We therefore suppose that the pressure state of ether created by a body is indeed the gravitational field of the body.

The state of particles -- in the case of photons, their speed -- must depend on the gravitational field φ. In order to clarify the dependence of photon speed on the potential φ, let us consider a solid resting on a horizontal surface. If we assume, for certainty, that the speed of light is greater in the upper part of the object, then the electromagnetic interactions in any upper region of indefinitely small size will occur more rapidly than the interactions in a lower adjacent region of the same size. That is to say, the equilibrium situation of the horizontal boundary between these regions must be lower than its actual position, viz. there appears a force directed downwards toward the equilibrium position. Therefore, *the speed of light decreases as it approaches a massive object.* As we can see, the gravitational field causes such an equilibrium disturbance of a resting solid body, as does an acceleration of an object in the absence of gravitational field – this is in agreement with Einstein's principle of the equivalence between the gravitational field and acceleration.

The gravitational field, analogous to acceleration, should not affect the transverse dimensions of a solid body. Therefore, the decrease of the speed of light in the gravitational field (as compared to its speed in the absence of gravitational field, at the same spatial metrics) causes the slowing down of any processes, thus time dilation. In turn, this decrease in speed may be considered as a lowering of the rest energy, and therefore, the rest mass of particles and bodies in the gravitational field (Einstein's conclusion [13]). In other words, the decrease in the rest energy of a particle will be proportional to the alteration of the gravitational potential $\Delta E = m\Delta\varphi$, i.e. will be equal to the lowering of the potential energy ΔU . *The relative lowering of the particle's rest energy $\Delta E/mc^2$ under changing gravitational potential must be equal to the relative energy decrease $\Delta\nu/\nu$ of a photon* that may be emitted by that particle. Thus, using the quantum mechanical formula $E = h\nu$, we arrive at the familiar Einstein's formula $\Delta\nu/\nu = \Delta\varphi/{}^2$. Obviously, the relative decrease of the speed of light is determined by the formula $\Delta c/c = \Delta\varphi/c^2$.

The above-mentioned dependence of the particle's rest mass on the change of gravitational potential, will be described by the expression $m\,(1 + \Delta\varphi / c^2)$. The Lagrangian $L = -\,mc^2(1 - v^2/c^2)^{1/2}$ will take the form

$$L = -\,m(1 + \Delta\varphi/c^2)c^2(1 - v^2/c^2)^{1/2}\ . \qquad (28)$$

For small velocities, i.e. in classical mechanics, we obtain, without any presuppositions, the familiar expression for the Lagrangian

$$L = m\,v^2/2 - \Delta U\,, \qquad (29)$$

where $\Delta U = m\Delta\varphi$.

In the theory of classical mechanics, the second term of this expression is forcedly introduced with a minus, so that the Lagrangian equations obtained would comply with the Newtonian law. Such an approach may testify to the theory's incompleteness. We should also note that, instead of the concept of a material point utilized in the contemporary classical mechanics, we have used *the notion of the excited state of some part of the ether*. This part of the ether must have a certain volume, whose non-zero value is the necessary condition for the motion in space.

The propagation of light in a gravitational field is known to result in a deflection of the light beam. One of the causes for the deflection is that *photons*, same as any other particles, *are accelerated in the gravitational field*. The second cause is that the speed of light depends on the gravitational field's potential, therefore *the front of a light wave, as also the front of a de Broglie wave, will turn toward the direction of lesser light velocity.*

We have emphasized earlier that moving particles do not drag ether. This conclusion contradicts the Big Bang Theory, because according to this theory, during the explosion there happened the recession of particles and the expansion of the Universe. We need to seek another explanation to the cosmological red shift discovered by Hubble. One of the possible ways to a solution emerges when we consider the emission of gravitational waves by a body having the mass *m*, during its rotation around a body with the mass M. The emission intensity, average with respect to the rotation period, is expressed as:

$$I = 32\, k^4 M^2 m^2 (M + m) / 5\, c^5 r^5, \tag{30}$$

where k is the gravitational constant, and r is the orbit radius, see [12]. We can estimate the energy loss of a photon having the mass hv/c^2 when it restrictedly moves within the body having the mass m and based on the estimation perform the calculations for photons propagation in gravitational fields. The average relative photon energy loss into the emission of gravitational waves during the photon propagation through a gravitational field created by the body with mass M, is given by

$$\Delta E / E = (5\, k^3 M^2 (k M)^{1/2} hv)/(r\, r_0^{5/2} c^9)\,, \tag{31}$$

where r_0 is the radius of that body. The numerical value of this expression is extremely little -- in the case of photon motion along the Sun at the distance $r = r_0$, its value is of the order 10^{-83}, therefore this approach is insufficient to explain the cosmological red shift.

Then there remains a single possibility, namely, the photons energy loss during their motion, in other words, *the dissipation of photon energy in the ether medium*. In this case, the energy lost by the light will be accumulated as *a dark matter.* Then such matter conversion may be assumed also for the free motion of other particles. On the other hand, we cannot exclude the possibility of an opposite conversion of the accumulated dark matter.

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